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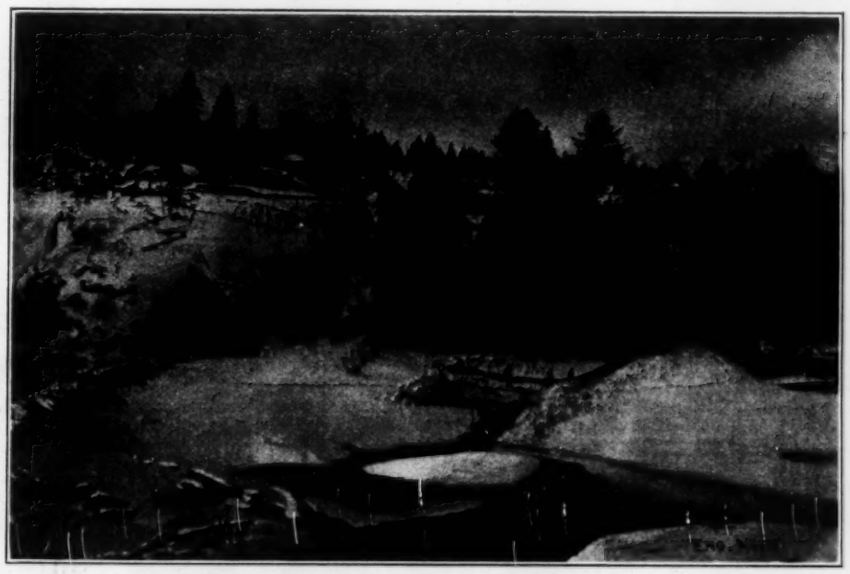
A LARGE REINFORCED-CONCRETE DAM AT ELLSWORTH, ME.

A new power plant which the Bar Harbor & Union River Power Co. is now erecting at Ellsworth, Maine, is to be equipped with a reinforced-concrete dam, which has probably the highest head of any structure of this particular type yet attempted. The plant is built on the Union River at the head of a steep pitch which discharges into tide water; in fact in extreme tides the water backs almost to the foot of the dam. The general layout is shown in Fig. 1 and consists of the reinforced-concrete dam of the hollow type patented by the Ambursen Hydraulic Construction Co. of Boston, leading the water into the power-house on the banks through two 8-ft. and one 3-ft. penstock with provision made for a 12-ft. penstock if needed.



VIEW OF DAM SITE, SHOWING WORK ON COFFERDAM ON ICE.

The dam proper is in two parts; a rollway 300 ft. long and 64.5 ft. high and bulkhead 120 ft. long and 71 ft. high, each of the same general type and differing only in size. Their construction is best illustrated by the sections shown in Figs. 2 and 3. The type of dam perfected by this company consists of an upstream and downstream face or deck slab interbraced by buttresses which are in turn connected by beams; the whole construction being of reinforced concrete. The buttresses are spaced 15 ft. c. to c. and vary in thickness from 24 ins. at the base to 12 ins. under the crest. They are founded on solid rock of varying elevation, in some cases rising to nearly half the height of the dam. The reinforcement, consisting of high elastic limit Johnson bars, is placed horizontally in the body of the buttress and horizontally and lengthwise of the faces where connections are made to the deck slabs. At these connecting points the extremities of the buttresses are formed into a tongue with recesses into which the deck slabs fit, thereby making an expansion joint in the slab at each buttress.

The slabs have a thickness of 14 ins. at the thinnest portion, 12 ft. below the crest and increase in thickness to 37-in. at the base and 24-in. at the crest. In addition to the horizontal tension rods shown on the drawings, diagonal bars are added to take up the shear in each portion of the slab between expansion joints. The cross-beams are tied well in to the buttresses and are reinforced at top and bottom as shown.

The mixture of concrete in the deck is 1:2:4 with 1-in. aggregate and laid very wet. The concrete in the buttresses and mass structures is a 1:3:6 mixture.

One of the principal claims of superiority made for this special design is the advantageous distribution of stresses. Owing to the long and low back slope the water behind the dam acts as a helping weight as well as an overturning force. The stresses in this particular section are shown in Fig. 2. It will be noticed that the dam is designed for a maximum flood of 6.5 ft. Under these conditions the resultant of the pressures on the base cuts the foundation 6.5 ft. upstream from the center line of the base instead of the downstream edge of the middle third as is customary in solid masonry dams. The maximum pressure on the buttress footings is 22,000 lbs. per sq ft., which is also practically the uniform pressure over the entire base, owing to the position of the resultant. The foundations are hard ledge. The maximum compressive stress in the concrete of the floor slab is 500 lbs. per sq. in. and in the steel, 12,500 lbs. per sq. in.

As the village and offices of the company are on the opposite side of the river from the power-house, the rollway of the dam is made use of in the usual way for access and inspection. Entrance to the bridge is had through a stair tower which connects with a passageway under the low portion of the rollway opening into the general interior of the structure. The lower part of the downstream apron is open with a series of arches so as to prevent a vacuum forming under the flow of water. Three 60-in. sluice gates are provided as shown, one in the bulkhead section and two in the rollway section. All three gates are accessible from the interior of the dam.

The bulkhead was too short to allow of the power-house being incorporated in the body of the dam. The power-house is therefore placed nearly at right angles to the axis of the dam and is supplied through a forebay, which takes its water past the end of the bulkhead. The forebay is defended by coarse racks and the penstock intakes by fine racks. A sluice gate in the rollway at the end of the bulkhead flushes off whatever trash may accumulate against the bulkhead. The power-house will be built on mass concrete foundations with a superstructure of concrete blocks. The main structure connects with the bulkhead of the dam and the space underneath the bulkhead is used for miscellaneous purposes, such as machine shop, store rooms, heating plant, toilet room, etc. Two turbines of 850 and 1,700 HP., respectively, are provided which drive two units 500 and 1,000 KW. each. Provision is made for a further enlargement of the plant whenever the demand for electric current in the towns supplied shall make such enlargement necessary.

The work was commenced last February within 24 hours after the contract was signed and is expected to be finished by Jan. 1, 1908. Advantage was taken of the heavy body of ice on the site last winter to construct the cofferdam for the works as shown in the view above.

The engineers for the company are Messrs. Sellers & Rippey, of Philadelphia, and their engineer on the work is Mr. J. A. Leonard. The contractor is the Ambursen Hydraulic Construction Co., of Boston, which is responsible also for the design of the reinforced concrete dam. We are indebted to Mr. W. L. Church, President of the Ambursen Co., for the information and drawings herewith presented.

SAND FILTERS AT BAR HARBOR, ME., AND SOUTH NORWALK, CONN., FOR THE REMOVAL OF ORGANISMS, TASTES AND ODORS FROM WATER.

By H. W. CLARK.*

During 1905 and 1906 sand filters for the removal of organisms, tastes and odors from the public water supply were built at Bar Harbor, Me., and at the present time filters for the same purpose are under construction at South Norwalk, Conn. The Bar Harbor filter plans were prepared by the late Freeman C. Coffin, in consultation with the writer. Mr. W. S. Johnson, M. Am. Soc. C. E., of Boston, has been associated with the writer in the preparation of the South Norwalk plans. Mr. L. D. Thorpe was engineer-in-charge at Bar Harbor, and at South Norwalk Mr. Samuel W. Hoyt is engineer-in-charge.

BAR HARBOR.

The Bar Harbor water-works were built in 1874 by the Bar Harbor Water Co. Water is taken from Eagle Lake, which is about three miles from the town, and at an elevation of about 276 ft. above tide water. The lake has an area of about 1,000 acres, or 1½ sq. miles, and a drainage area of 3.75 sq. miles. The shores for the most part are abrupt, the lake being surrounded by high hills, and the lake is reported to be of great depth. There are few, if any, houses on the drainage area. The normal population of Bar Harbor is about 3,000. During four months in summer this population is increased by summer visitors to about 10,000. The consumption of water per capita is large, being about 250 gals., or a total daily consumption in summer of 2,500,000 gals. The water is measured by a Venturi meter, located about 1,000 ft. from the lake. No meters are installed on the services. The water is generally colorless and of excellent quality, but at times during certain seasons there has been trouble with it due to tastes and odors.

*Chemist, Massachusetts State Board of Health, Boston, Mass.

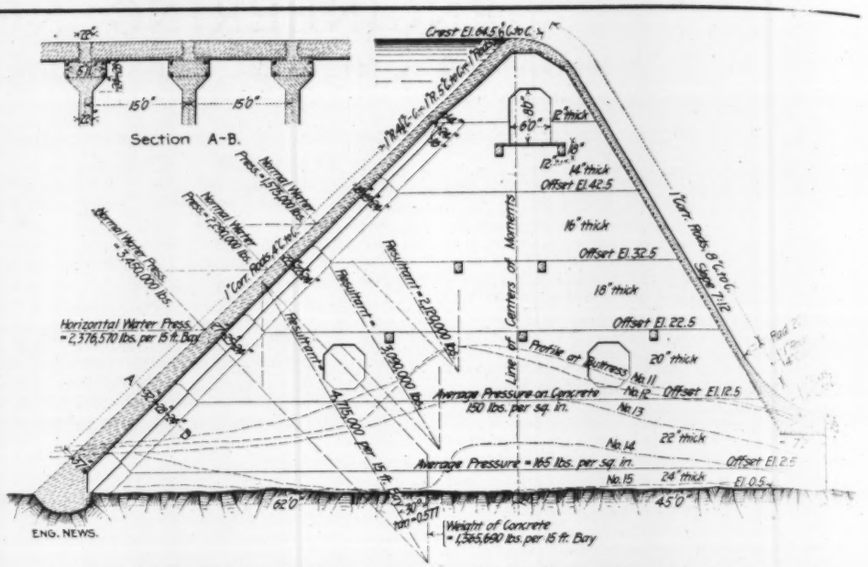

Section A-B.
Crest El. 64.5
Horizontal Water Press. = 2,376,570 lbs. per 15 ft. Bay
Weight of Concrete = 1,385,690 lbs. per 15 ft. Bay
ENG. NEWS.

FIG. 2. SECTION THROUGH ROLLWAY OF REINFORCED CONCRETE DAM AT ELLSWORTH, MAINE.

The first serious trouble of this sort was experienced during the season of 1893. No further trouble occurred until 1896, but during that year and 1897, and also in 1900, the water was again of an exceedingly poor quality, owing to these tastes and odors, for considerable periods. In 1905 the water again became bad, and the trouble was more serious at this time than during the previous seasons. The tastes and odors began about May 15 and lasted until early in July, the water being practically unfit for domestic purposes for over a month. In 1900 and again in 1905, the writer was called in by the Bar Harbor Water Co. to locate the trouble. In 1900, while it was believed that Uroglena was the cause of the trouble, the organisms had practically disappeared before samples were taken. In 1905, however, the water of the lake was found to contain Uroglena in large numbers, and the water as distributed in the village had an exceedingly offensive taste and odor, due to the disintegration of these organisms in the supply system. A report was made to the President of the Bar Harbor Water Co. in regard to the condition of the water, and as the trouble had been experienced so frequently the company decided to take measures to prevent such annoyances in the future. After a full discussion of the matter, double filtration of the water was recommended. The efficiency of this

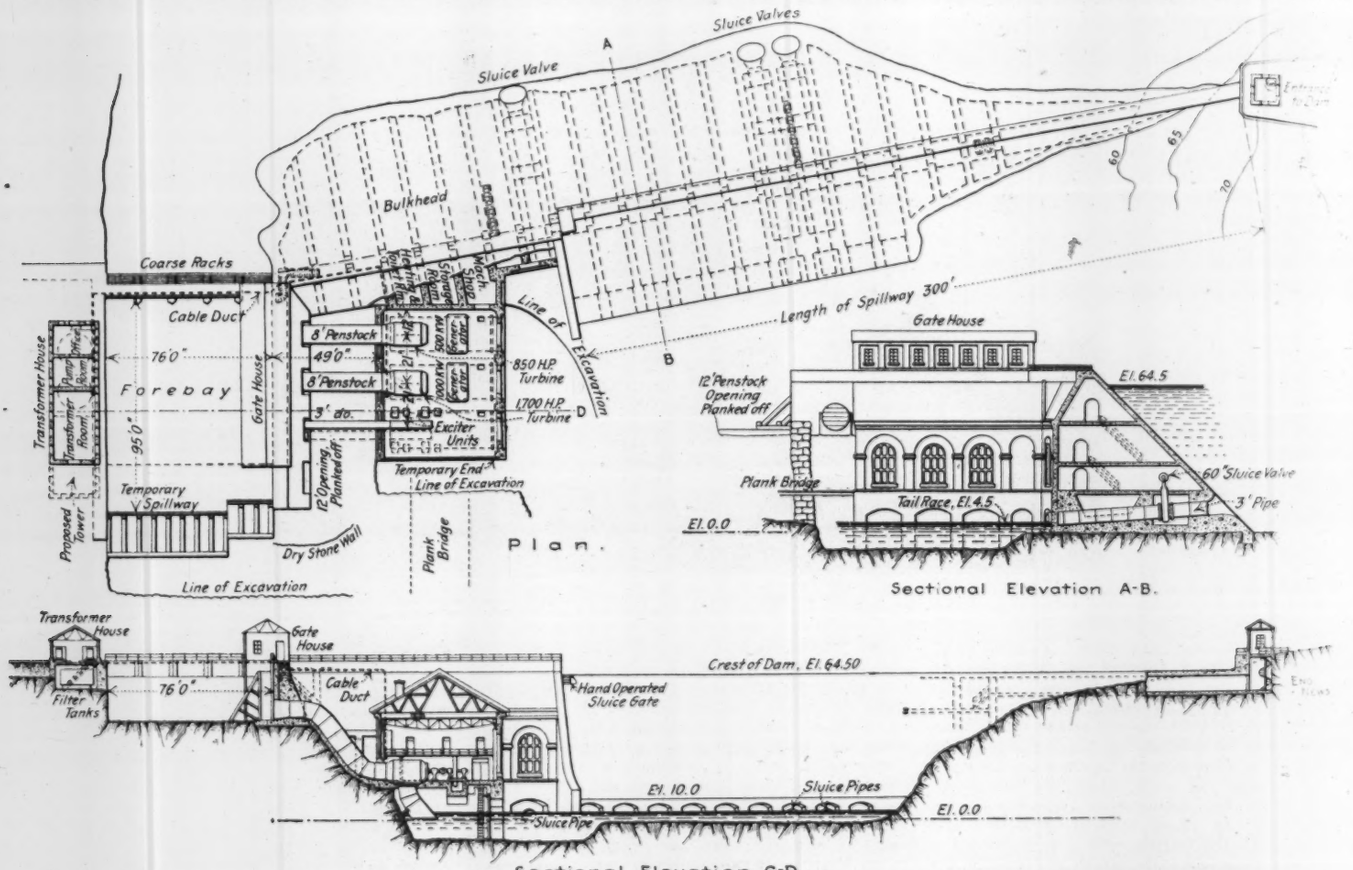


FIG. 1. GENERAL LAYOUT OF POWER PLANT OF THE BAR HARBOR AND UNION RIVER POWER CO. AT ELLSWORTH, MAINE.

had been tested by the Massachusetts State Board of Health at Springfield, Mass.,* and also at Ipswich, Mass. At the latter place Uroglena and its accompanying tastes and odors had been successfully removed by experimental sand filters. Small experimental filters were also operated for a short time at Bar Harbor under the advice and direction of the writer.

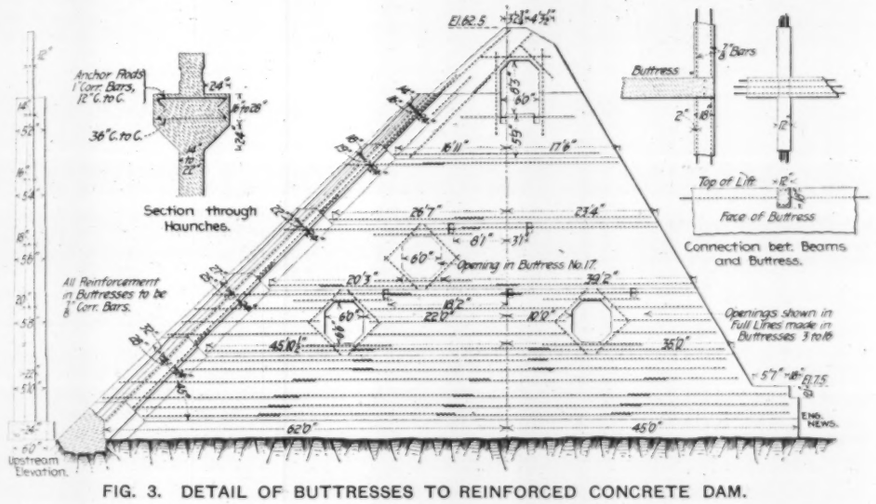
The general plan of filtration to be followed, size of filters required, rate of filtration, methods of aeration, etc., was suggested by the writer, and the detailed plans and specifications, as before stated, were made by Mr. Coffin.

It was decided to construct sand filters of a capacity of about 2,500,000 gals., or of a sufficient area to provide for a maximum consumption. These filters were ready for use about Sept. 1, 1906. The filter plant is located 600 ft. from the lake and at such an elevation that the water flows upon the filters by gravity. The dimensions and general description of the filters are as follows: The primary filter is 153 × 155 ft. in plan, or practically one-half acre in area. It is divided through the center, thus forming two separate sections, either of which can be used independently of the other. Each section has a sand area of 11,884 sq. ft. The secondary filter is 108 × 123 ft., or a little more than one-third acre in area. A concrete aerating chamber, 14 × 16 ft., inside dimensions, has been constructed, through which the water can be passed before going to the primary filter. The chamber is divided through the center, each side being connected to a supply pipe from the lake. A float valve is placed on each connection and so arranged as to close automatically, thus shutting off the flow from the lake when the elevation of the water in the primary filter reaches the high water line or overflow point. The water, after entering through the float valves, is held back in the chamber by stop planks until it reaches an elevation high enough to flow onto the aerating devices. These aerating boxes, or pan contains 6,000 holes, 3-16-in. in diameter, each suspended by four bolts, 3½ ft. long, one at each corner of the pan. By means of these bolts, which are threaded for 2 ft. in length, the pans can be raised or lowered as the elevation of the water in the lake may demand. Each pan is 7 ft. 7 ins. long, and 6 ft. 10 ins. wide, the bottoms being of brass ⅛-in. thick, riveted to 3 × 4-in. angle irons, which form the sides. Each pan contains 6,000 holes, 3-16-in. in diameter, space 1-in. c. to c. From each side of the aerating chamber a 20-in. vitrified pipe leads into a small chamber, one being located at the end of each filter. The water flows from these chambers onto the surface of the sand. After passing through the primary filters the water enters a regulating chamber, which is located at the lower end, and is here measured through an orifice, the rate of flow being governed by sluice gates at the main outlets. From each regulating chamber the water flows through a 20-in. vitrified pipe into a second aerating chamber, which is provided with a 20-in. float valve so adjusted that it will close at the time the water in the second filter reaches the overflow point. The chamber is also arranged with stop planks, in such manner that the water from the primary filters is held back until it reaches an elevation high enough to flow into aerating pans. These aerating chambers and pans are of the same construction as those in use in the aerating chamber for the primary filters. The filters are so arranged that the secondary filter can be connected directly with water from the lake. The primary filter can also be used independently of the secondary filter. The sand in the primary filters is 2½ ft. deep, and rests on gravel underdrains. The main underdrains through the center of the filters are of concrete, 12 × 16 ins. sq., and are covered by 3-in. concrete slabs. From the main underdrain 10-in. split tile pipes, spaced 15⅔ ft. c. to c., extend to within 2 ft. of the foot of the slope of the wall.

In the secondary filter the sand is of practically the same depth as the first, and over the same gravel underdrains. The main underdrain for this filter is 15 × 20 ins., and is also built of concrete. From the main collector 12-in. split tile pipes are laid to within 2 ft. of the wall. The filters are entirely of reinforced concrete. While not covered as yet, as it is thought that it will probably be necessary to use them in summer only, still foundations for piers have been built for use in case it should be necessary in the future to cover the filters. The vertical ¾-in. twisted steel rods, 12 ins. apart in the side wall, are left projecting about 18 ins. above the top of these walls. The bases of the piers are also built to a height of about 2 ft. and are spaced 15⅔ ft. c. to c.

A filtered water well is located at the lower end of the filter. It is 29.67 × 108 ft. in plan, 7 ft. in depth. Its total capacity to the overflow point is 160,000 gals. About 3,000 cu. yds. of sand have been used in these filters. The sand was brought by vessels for about ten miles and then hauled for about three miles to the filters. The total cost of the sand, delivered to the filters, was $3.57 per cu. yd., and the total cost of the filters to date has been about $50,000.

*See report of H. W. Clark in regard to the Filtration of the Water Supply of Springfield, Report of Mass. State Board of Health, 1901.


Anchor Rods 1" Corr. Bars, 12" c. to c.
36" c. to c.
Section through Haunches.
Buttress
7/8" Bars
Top of Lift
Face of Buttress
Connection bet. Beams and Buttress.
All Reinforcement in Buttresses to be 7/8" Corr. Bars.
Opening in Buttress No. 17
Openings shown in Full Lines made in Buttresses 3 to 16
El. 62.5
El. 8.75
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Upstream Elevation.

FIG. 3. DETAIL OF BUTTRESSES TO REINFORCED CONCRETE DAM.

SOUTH NORWALK, CONN.

The South Norwalk water-works, as begun in 1875, included two storage reservoirs, one having a capacity of 165,000,000 gals., at an elevation of 323 ft. above tide water, and one having a capacity of 12,000,000 gals. at 222 ft. elevation. In 1902 a third reservoir was built between the first two at an elevation of 266 ft., and with a storage capacity of 500,000,000 gals. The water from these reservoirs has been frequently of a poor or unsatisfactory quality, owing to the growth of organisms and their resulting tastes and odors. Improvement of the supply by filtration has been agitated for many years. In 1896 and again in 1904 filtration was advised by the writer. In August, 1904, the writer was retained to prepare filter plans, and in association with Mr. W. S. Johnson, M. Am. Soc. C. E., such plans were prepared. Owing to various delays, preparatory work for the construction of the filters was not begun until the fall of 1906; but such construction is now under way by the Bunting Construction Co., whose bid of $70,000 for the work was accepted by the South Norwalk Water Commissioners. The price named does not include payment for filtering material.

The sand filter plant, as planned, has a total area of 1¼-acre. It is covered by concrete groined arch construction. Of the total area, one acre is a primary filter and one-fourth acre a secondary filter. The primary filter is divided into four beds of a quarter acre each, the dimensions of each bed being 78½ × 145 ft. It is planned to have 3½ ft. in depth of sand in the primary filter and 2½ ft. in depth in the secondary filter. Before going to the primary filter the water is to be aerated by being passed through a steel tank 6½ ft. × 9¼ ft. in plan, with a bottom perforated with 3-16-in. holes, spaced 1-in. c. to c. The water will have a drop of 2½ ft. A similar aerator is to be used in connection with the secondary filter.

A CHRONIC TYPHOID FEVER PRODUCER.*

During the summer of 1906 the speaker devoted a part of several months to an investigation into the source of a household epidemic of typhoid fever occurring in Oyster Bay, N. Y. Of 11 persons 6 developed positive cases of typhoid between Aug. 27 and Sept. 3. Several suspected sources, water, milk, vegetables, fruit, and soft clams, were excluded by careful study and examination. Repeated sanitary analysis of the water supply and failure to detect subsoil pollution by fluorescein tests of the drainage showed that the infection was not water borne. Typhoid was unusual in Oyster Bay and there were no cases immediately preceding or following those under consideration. The milk and food supply of the infected household were common to others of the village without the occurrence of other cases. None of the patients had been absent for several weeks prior to the outbreak, and they therefore had acquired it on the premises. The house and surroundings were in an entirely hygenic condition. The investigator inferred the occurrence of some unusual event prior to Aug. 20, and found it in a change of cooks on Aug. 4. The new cook's term of service with this family covered a period of three weeks prior to and three weeks subsequent to the outbreak. She refused to give any information tending to connect her with the cases, but an independent investigation of her previous service disclosed a startling and significant history of typhoid. Despite the fact that her record for nearly two of the past five years is yet unknown, 26 cases of typhoid fever, including one death, were associated with her service in seven families during this time. The cases were almost entirely among the servants, and the initial case frequently occurred soon after the arrival of the cook. She did not directly admit having herself suffered from typhoid, but to three persons she is said to have previously testified to a mild attack.

The evidence indicating the cook to be a competent cause of typhoid, she was taken into custody by the New York City Department of Health, March 11, 1907, and at the detention hospital a bacteriological examination was made. She was a large healthy Irishwoman, 40 years of age. The urine was free of typhoid bacilli, but the stools showed great numbers nearly every day for the several weeks of observation. The blood gave a positive widal reaction. Thus a healthy and vigorous subject was shown to be a chronic typhoid fever producer. As the typhoid organism is known to persist for years in the gall bladder, this is the presumed source of the infection, removal of which requires the consent of the subject.

The speaker called attention to recent papers by Dr. Robert Koch and others on the important investigations in western Germany of typhoid outbreaks by the aid of portable or "flying" laboratories. To the Germans the dangers of bacillus carriers are well known. Stress was laid on the importance of contact in transmission and on the analogy in this respect between typhoid and diphtheria and tuberculosis. A careful campaign is necessary to discover bacilli carriers once they escape the physician's care. The rigorous measures of isolation and disinfection

*Abstract of a paper (and of discussion) by Dr. George A. Soper, M. Am. Soc. C. E., 29 Broadway, New York City, presented before the Biological Society of Washington on April 6, 1907. The abstract is taken from advance sheets of the report of the meeting, which will appear in "Science." For the abstract as here printed we are indebted to Mr. M. C. Marsh, Recording Secretary of the Biological Society of Washington (U. S. Bureau of Fisheries).

adopted in Germany are perhaps impracticable here at the present time, except during epidemics.

In the discussion which followed, Dr. W. C. Woodward, Health Officer of the District of Columbia, commended the accuracy and the scientific spirit of Dr. Soper's work and spoke of the desirability and the difficulty of procuring such accuracy in the routine work of a health department and in obtaining for such routine work men imbued with the same scientific interest as that displayed by Dr. Soper. The extreme difficulty of detecting bacillus carriers and isolating them after detection would constitute a serious obstacle in the way of preventing the spread of disease through them. The public should guard, however, against forming exaggerated ideas of the danger from this source. Among the many hundreds of patients suffering from typhoid fever who have come to the knowledge of the Health Department during recent years, many were housewives and other persons who, upon convalescence, necessarily took an active part in the ordinary affairs of the household. And although many of such cases must have been what are now termed bacillus carriers for longer or shorter periods after convalescence, the Health Department had yet to find a case in which there was an outbreak of typhoid fever, or even a second case, in the household after the convalescence of the first case.

Dr. Woodward asked why it was that in the families in which the bacillus carrier which formed the subject of Dr. Soper's investigation, had been employed, the numbers of the members of the families affected by the disease was apparently relatively so small as compared with the number of persons affected among the persons employed about the household and about the premises.

Dr. M. J. Rosenau said that the typhoid problem is now magnified and the difficulty of dealing with it increased. Though complex and intricate, the situation is not hopeless. It is not necessary to imprison the bacillus-carrier; it is sufficient to restrict the activities of such an individual. As for typhoid in Washington, if largely transmitted by bacillus carriers and contacts, a different epidemiological picture might be expected; the disease should increase progressively, whereas it is epidemic in the summer, declining rapidly in the fall; there is little typhoid fever here in the winter and spring. Dr. Rosenau believes that when large quantities of virulent cultures are ingested the disease is frequently induced within the usual period of incubation. Ordinarily, however, persons become infected with dilute cultures or attenuated bacteria which remain in the intestinal tract awaiting lowered resistance before the disease manifests itself. This lowered resistance is largely brought about by the enervating effects of the hot weather. This explains the seasonal prevalence of typhoid fever and why it is a summer disease in Washington and many other places.

Dr. L. O. Howard, while appreciating that a charge of professional bias might lie, felt it necessary to emphasize the role of the housefly as a carrier. Whether its importance is secondary, tertiary, or further removed in degree, it is certainly known to transmit typhoid, even under city conditions. The housefly is abundant in low quarters and near waste lots in cities like Washington. To do away with it is a simple matter. It is but necessary to oblige stable keepers to dispose of horse manure, since 99% of the houseflies in cities are bred in it.

Mr. K. F. Kellerman said that Doctor Soper's typhoid investigations have shown weighty reasons for the sterilization of sewage. Chemical sterilization is practicable at low cost, by nascent chlorine or one of the heavy metals, and should be resorted to when sewage is discharged into streams which in a short time are used as the sources of drinking water. He seconded Doctor Howard with respect to the importance of flies. At Panama typhoid is rare, and the few cases are confined to the lowest classes of negro laborers who eat in the open where flies are abundant instead of in screened dining rooms, such as are used by the Americans.

Dr. J. Goldberger gave some figures on the frequency of bacillus-carriers: 1,700 cases examined at three of the laboratory stations in Germany showed 3% to be chronic carriers.

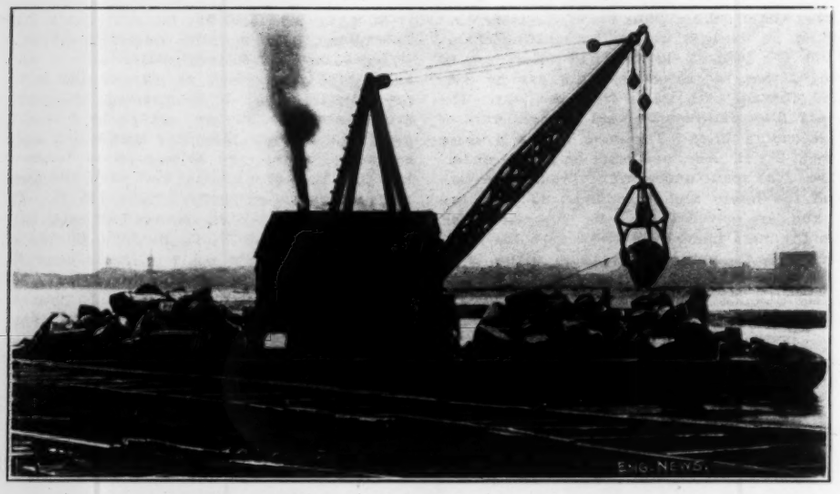


FIG. 1. FLOATING DERRICK AND GRAPPLE FOR REMOVING RIPRAP UNDER WATER AT SUPERIOR ENTRY, WIS.

Dr. G. Lloyd Magruder recalled the early typhoid investigations in Washington and the surrounding country which indicated the water supply, cesspools, manure piles and milk as carriers. The city wells and water supply of many dairy farms were found contaminated. It is difficult to enforce sanitary precautions in the city and almost impossible in the country. The farm is an important source of city typhoid, and the fly an important carrier on the farm.

Dr. Soper, in closing, replied to questions and amplified certain points. With respect to the cost of his investigation he preferred to give no figures. It had cost him personally more than he had agreed to charge at its beginning. The investigation would hardly have been undertaken in this particular instance, save for its scientific interest. His typhoid work was generally done for cities, as at Ithaca and Watertown. As to why more persons other than the servants were not attacked in the families served by the cook, he believed the members of the family were protected in large measure by the sterilizating effect of cooking, the food being chiefly handled, after cooking, by butlers and waitresses or servants other than the cook. The cook never handled fruit, salads and other things eaten raw by the family. Servants newly attached to the household were more apt to take the disease than those long associated with the cook. Possibly an acquired immunity explains this. Hand infection is important, and the hands should receive more attention than they do. It would be well if cooks could be selected only after careful assurance concerning their histories and personal habits. In general, scrupulous cleanliness is an important safeguard against typhoid. Increase in knowledge of bacillus carriers should be looked upon as encouraging rather than otherwise, since it is only by knowledge of the facts that preventive measures can be accurately applied and transmission can be prevented.

A FLOATING DERRICK FOR HANDLING HEAVY RIP-RAP STONE.

The harbor improvement work now being carried on at Superior Entry, Wis., under the direction of the United States Engineer Corps, includes the removal of some submerged rip-rap, and we illustrate herewith a floating derrick and grapple specially designed for this work. For particulars and drawings we are indebted to Mr. Clarence Coleman, M. Am. Soc. C. E., U. S. Assistant Engineer, and Mr. M. W. Lewis, U. S. Junior Engineer, of Duluth, Minn.

The design and construction of this machine was made necessary by peculiar and difficult conditions. Under the existing project for the improvement of the harbor entrance at Superior Entry it is necessary to remove some 65,000 tons of large rip-rap in pieces of 2 to 10 tons weight from depths of 5 to 20 ft. below the surface of the water. The Nemadji River, a silt-bearing stream, empties into Superior Bay at a point almost opposite the canal entrance, and as its water flows out to Lake Superior through this entrance it produces a condition of opaqueness in the water during the working season that renders it impossible to distinguish objects within a few feet of the surface. Under these conditions, engineers and contractors were skeptical as to the success of handling invisible rock with a grapple device of any description.

The machine referred to is shown in Fig. 1. It consists of a scow carrying a revolving derrick of 10 tons capacity, which handles the grappling device. It was designed and built by Mr. Coleman and Mr. Lewis, under the direction of Maj. Chas. L. Potter, Corps of Engineers, U. S. A., until Aug. 3, 1906, and after that to its completion in October, 1906, under the direction of Maj. Graham D. Fitch, Corps of Engineers, U. S. A. It was operated very successfully and economically until the close of the working season of 1906, and demonstrated its ability to cope with the difficulties of the situation without any unusual hindrances.

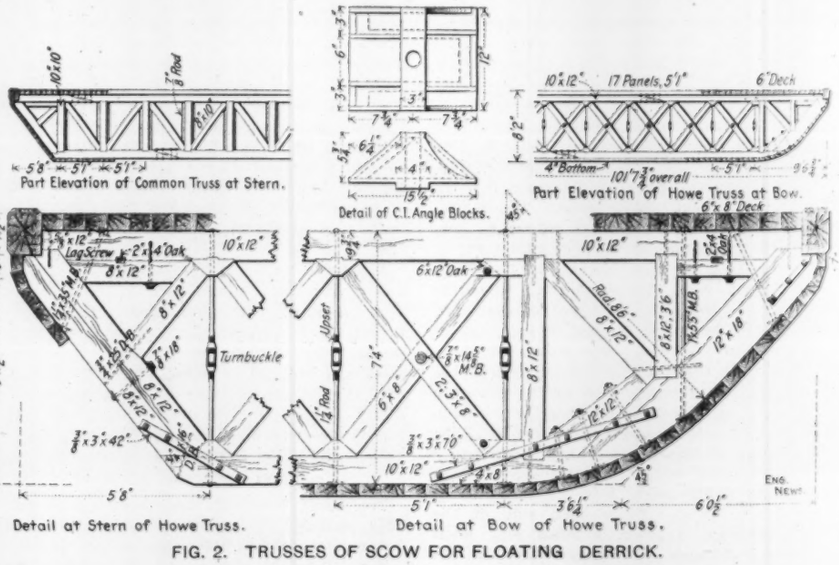

Part Elevation of Common Truss at Stern.
Detail of C.I. Angle Blocks.
Part Elevation of Howe Truss at Bow.
Detail at Stern of Howe Truss.
Detail at Bow of Howe Truss.
ENG. NEWS

FIG. 2. TRUSSES OF SCOW FOR FLOATING DERRICK.

The scow is of timber, of massive construction; it is 102 ft. long, 32 ft. wide and 8 ft. deep. It is composed of a system of three Howe trusses and two common framed trusses, together with the side walls and four cross trusses, all of which combine to give great stiffness. The construction is shown by the sectional elevations in Fig. 2, and by the plan of the framing in Fig.

3. The vertical tie-rods of the Howe trusses have turnbuckles, which allow for subsequent adjustment, and special hollow cast-iron angle-blocks were used in these trusses, as shown. A deck of 6-in. fir planking was laid, this thickness being designed to provide against damage by the impact of rocks handled by the grapple. The side planking is 8x10 ins., and that of the ends and bottom 4x10 ins.

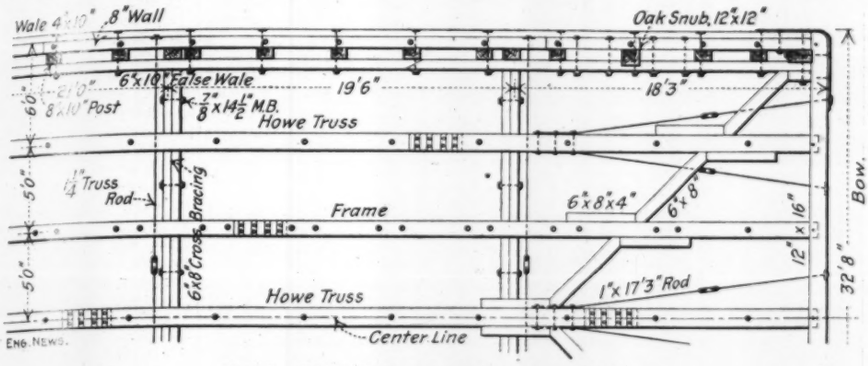


FIG. 3. PART PLAN OF FRAMING OF SCOW.

Near the center of the scow is placed a revolving steel platform to carry the boom and A-frames. This is built up mainly of 10-in. 40-lb. I-beams, and beneath the 10-in. circular beam is an inverted 60-lb. rail; the head of this rail rests upon 16 grooved conical rollers, 8 ins. diameter on the center line and 4 ins. wide in the groove. These are journaled on solid axles in the ends of radius rods formed of 2-in. pipe, swaged flat at the inner ends and there bolted to a flat ring encircling the center casting. The rollers ride upon a second circular track of 20 ft. diameter, composed of 60-lb. rails secured to the deck of the scow. This turntable construction is shown in Fig. 4. All movable parts of this platform are securely fastened at the center casting to heavy interior cross beams, so that upward stresses which may occur on the center pin at times of heavy loading are distributed directly to the top chords of the three central trusses. The platform turns very easily, even under heavy loads.

To support the head of the boom a double set of timber A-frames is employed, resting upon

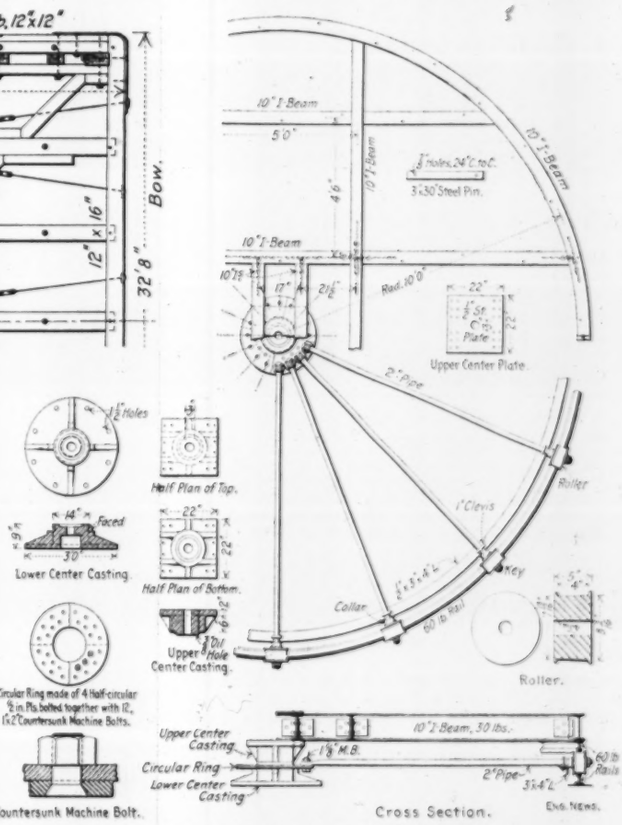


FIG. 4. TURNTABLE FOR FLOATING DERRICK.

pattern, 40 ft. 3 ins. long over all, and with a spread of 10 ft. 2 ins. at the base. As shown in Fig. 5, it consists of two timber diamond trusses, securely braced, and reinforced at the head with stiffening plates.

The boom cable of the hoist leads from the drum to the top of the A-frame, while the fall or grapple cables lead directly to the head of the boom. The platform is revolved by a separate double-cylinder engine, with cables arranged as shown in Fig. 6. Each cable passes over a pair of 10-in. guide sheaves and then around on the circumference of the lower or fixed 60-lb. track rail. The ends of these cables are secured to the deck and framework of the scow and have special cushions made from car springs. The swinging mechanism allows the boom to revolve

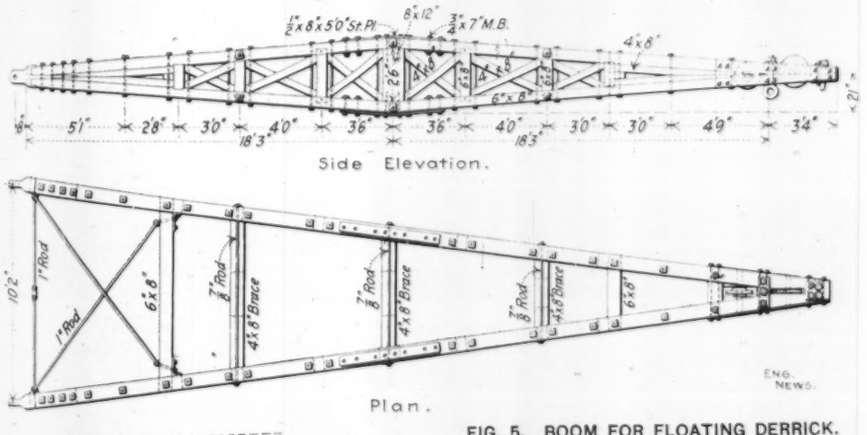
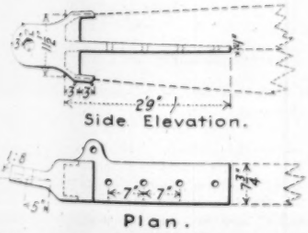


FIG. 5. BOOM FOR FLOATING DERRICK.



and securely fastened at points near the outer edge of the revolving steel platform; these are brought together at a point directly over the center of the platform, thus forming a pyramidal frame. This construction differs from the usual in either direction, and to entirely cover either end of the scow. The boom covers an area with a radius of from 14 to 48 ft., and the head has a maximum height of 48 ft. above the deck of the scow. The machinery is operated by a 30-HP. steam engine with two cylinders 8½x10 ins.; steam is supplied by a vertical boiler 42 ins. diameter and 8 ft. high. Besides the weight of boiler, engine, coal, etc., a counterweight of 8 tons is carried on the rear of the revolving platform.

The machine has been constructed to handle riprap blocks up to 10 tons in weight. The grapple used was designed especially for this class of work, and its main feature is the use of five teeth arranged somewhat on the principle of an "orange peel" grapple. The construction of this is shown in Fig. 7. For handling gravel, boulders and small rock, a seven-tooth grapple has been constructed, Fig. 8. All parts of these grapples, except the pins and chains, are made of cast steel well annealed.

Working under ordinary conditions, where the riprap is of various sizes ranging from one to ten tons, a uniform rate of from 40 to 60 tons per hour can easily be maintained.

Besides the foreman of the crew, one engineman, one fireman and two laborers are all that are necessary to operate the plant.

In reply to an inquiry as to whether similar derricks have been used on the Great Lakes in handling concrete blocks, etc., Mr. Coleman states that so far as he knows this derrick is of original design. A large block-setting derrick was used in breakwater construction at Buffalo Harbor in 1890. This, as briefly described in the report of the Chief of Engineers, U. S. Army (1890, Part 3, page 2,823), had no mast; the boom swung on a pintle in the deck and was guyed by a 2-in. rod attached to a cap on a frame composed of four inclined posts. It was swung by a tag line led from the boom through a snatch block to the winch head on the engine. The blocks were 6 ft. × 4 ft. × 4 ft. 2 ins., and weighed about 7½ tons. The large floating derricks used in more recent harbor work at Buffalo were described in our issues of May 16, 1901, and May 29, 1902.

Another block-setting derrick, having friction tongs for holding the concrete blocks, was used at Cleveland Harbor in 1898. This was a self-propelling barge or scow with two derricks, the larger one handling the tongs, which were of the "ice tongs" pattern; each arm was a heavy flat bar, on edge, of the required shape. The blocks weighed about 11 tons (Report of Chief of Engineers, U. S. Army, 1898, page 2,676, plates 3 to 6). Mr. Coleman also used a floating derrick for setting concrete blocks at Marquette Harbor in 1895 to 1897 (Engineering News, Jan. 21, 1897).

None of these block-handling derricks, however, conform to the design of the grappling der-

rick above described, the special features of which are: (1) the automatic grappling device, and (2) the fact that it automatically picks up blocks submerged in muddy water, where it would be impracticable to operate any ordinary sling or hook attachments.

THE MOVEMENT OF FREIGHT CARS ON AMERICAN RAILWAYS.

The matters of freight car interchange and freight car movement have in the past had little interest for engineers other than those directly engaged in railway service. The past year, however, has witnessed a freight car shortage so widespread and so calamitous in its effects that the question of freight car distribution and supply has become one of national importance and of immediate interest to manufacturers and merchants in all lines of business.

Few outside the railway service know anything of the system under which the two million freight cars on American railways are moved and kept track of. In the last issue of the International Railway Congress Bulletin, Mr. W. F. Allen, Assoc. M. Am. Soc. C. E., Secretary of the American Railway Association, describes in a very clear manner the operation of freight car interchange in the United States. We have deemed it worth while to reprint this paper, nearly in full, and to follow it by extracts from other notable recent contributions to the vexed problem of car shortage:

The Interchange Use of Freight Cars.*

By W. F. ALLEN.†

The interchange of freight cars among the numerous railways of the United States, Canada and Mexico, is a business of great moment, and its regulations have of recent years become of more and more interest to American railway managers. A large proportion of the freight traffic is transported long distances without break of bulk, and the car in which the lading is first placed consequently often passes over many different systems of railroads in proceeding from its point of shipment to its destination.

For many years, in fact from the beginning of through traffic up to July, 1902, the owner of the car was entitled to receive from the company using it, a certain rate per mile for each mile it was moved whether loaded or empty. This charge by mutual consent, but without any binding agreement, was established at 0.75-ct. per mile. At that rate, it remained for a number of years until October, 1894, when it was reduced to 0.6-ct. per mile. Higher rates were paid for certain classes of special cars, but the great bulk of the freight car equipment of the country was moved at this mileage rate.

One peculiarity of this system was that the accounts were kept by the user of the car, and that it was very difficult for the owner to verify the statement. In fact it was practically impossible to do so for the greater part of the cars in use. The figures were compiled primarily from the reports of the conductors of the freight trains and these were in the keeping of the users of the car. This placed a temptation in the way of the officials of impecunious roads, and it was sometimes charged that false statements of the mileage were made to the detriment of the interest of the owner of the car. Another disadvantage arose from the fact that no compensation was paid for the use of the car while it remained upon sidings awaiting loading or unloading, a period which often covered many days. It was generally considered at that time, that where reports were honestly made, the accounts pretty well balanced each other in the long run, and proposed changes in the system of interchange charges received but little attention from the higher grade of railway officials.

In 1888 however, an attempt was made to introduce a reform method of accounting by using what was called a "mixed per diem rate." The principle upon which this plan was based, was that the owner of the car was entitled to receive a certain amount for each day it was in use, to cover the interest on its cost and the depreciation, and to an additional mileage rate to compensate for the ordinary wear and tear caused by its movements on the rails. The attempt of 1888 failed, however, because as it was claimed by its advocates, the agreement for its use did not include a sufficient number of roads, and because it was not continued sufficiently long to thoroughly test its advantages. In 1893, the mixed system was again reported upon favorably by a committee of the American Railway Association, but it was never generally adopted. The rate then recommended was 0.5 ct. per mile and 6 cts. per day. In the course of the investigations made by this committee, it was developed that the average daily movement of a freight car was less than 25 miles.

The principal cause of the small daily movement of freight cars, is their detention at loading and unloading points. In order to remedy this evil, "car service associations" were formed at many of the larger terminals, and a demurrage of $1 per day was exacted from the consignee of the car for any detention in excess of an agreed time, generally 48 hours. The business of these associations is in charge of a manager, and his supervision, in many cases, includes not only the terminal city, but also other points in the adjacent territory. Provision is made to relieve the consignee of this charge, where the circumstances warrant it. These associations are, for the most part, self supporting, and their operations serve to considerably relieve the congestion of cars at terminals and to release them for further service. Uniform general rules to govern these associations were adopted by the American Railway Association in October, 1889. Each has its own local rules.

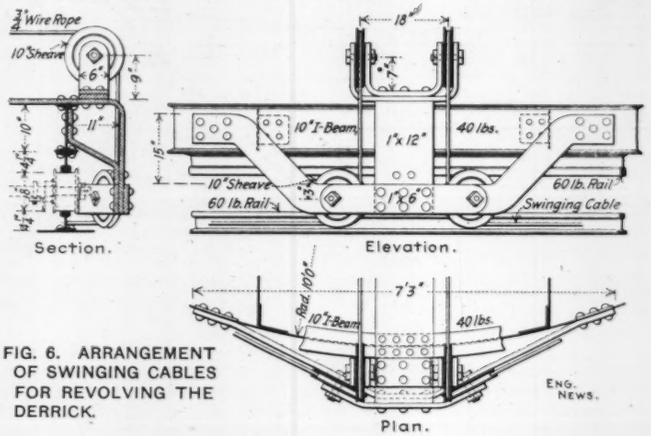


FIG. 6. ARRANGEMENT OF SWINGING CABLES FOR REVOLVING THE DERRICK.

The miles operated by the railways which are members of the American Railway Association increased from 145,860 in 1894 to 228,608 in 1906, and the cars owned from about 1,000,000 to over 2,000,000.

With this increase in number of miles of road and in cars owned, the interchange car service has correspondingly increased and become much more important. It had been often urged that the true method of settling for interchange car service was upon the basis of a daily charge, or as it was technically called "straight per diem." Many arguments were used against the adoption of this method of accounting although it possessed the obvious advantage of enabling the owner of the car to verify the statements and so to collect all that was due him. It was feared that the payments would become unduly burdensome to terminal lines, that the storing of cars in anticipation of traffic, a custom long in vogue, would become impracticable, and the profits of transportation frequently wiped out by the accumulated per diem charges.

In 1895, the question of the adoption of a per diem rate of 15 cts. a day was submitted by letter ballot to the members of the American Railway Association. It was favored by 77 roads owning 490,271 cars and opposed by 77 roads owning 394,669; the owners of 235,000 cars did not vote. As by the terms of the vote it required the assent of the owners of 840,000 cars to adopt the proposition, it was declared lost. In April, 1902, the Committee on Car Service of the above Association again reported in favor of the adoption of a "straight per diem," this time at the rate of 20 cts. per day. It accompanied its report with a carefully compiled set of rules to govern the interchange service, which rules provided for a "reclaim" of the amounts of per diem paid under certain conditions similar to those above mentioned. It provided also for an arbitration committee to settle all disputes that might arise under the operation of these rules.

When the report was being formulated by the committee, two rates of per diem charges were considered, 15 and 20 cts. As 25 miles per day at 0.6 ct. per mile is the exact equivalent of 15 cts. per diem, that seemed to be the logical rate, since an increase in the charge was not the object sought. It was thought, however, that the new system would result in an increased movement and the rate recommended was fixed at 20 cts. per day.

The report of the committee was presented at the meeting of the American Railway Association held April, 1902, and its adoption was vigorously fought by the representatives of those companies who believed that the expenses of their lines would thereby be largely increased. The Association voted to recommend the adoption of the per diem rate and the accompanying rules, but left the final decision to a vote by letter [illegible] with the rather rigorous provision that it sho[illegible] not be adopted unless favored by a majority of th[illegible] members of the Association owning or controlling two-[illegible]s of all the freight cars owned by the entire membe[illegible]. This provision, it was thought by some, would [illegible]vent the success of the movement, but on May 27, 19[illegible] the Secretary was able to announce that the requ[illegible]d assents had been filed. The new per diem rates under the terms of the resolution, therefore, took effect July 1, 1902. In order to put the new rates into practical effect a formal agreement was entered into between the roads concerned; this was signed by [illegible]% of the members of the Association representing [illegible]% of the cars owned.

As the first apparent result from the new regulation was an increase of one-third in the cost of the use of "foreign" cars, an expense regarded by many as already large, orders were given in all parts of the country to send such cars to their "home roads"; that is to the road that owned them. These orders were generally obeyed, and cars came pouring in upon their own rails at a remarkable rate. It is safe to say that at no time in the history of American railways have the several companies had as many of their own cars upon their own rails as on July 1, 1902.

One special provision of the per diem rules was that a road had the right to demand the return of its car after it had been on another road for a period of twenty days. Upon making such a demand upon a specified form called a "penalty notice" it could exact a "penalty rate" of $1 a day if the car had not been returned in 10 days thereafter; that is within 30 days in all. It had frequently been the case that cars were away from their home roads for months at a time, and this penalty clause was provided with a view to securing their prompt return. Owing to the contingencies of traffic, it was felt that the penalty rate could be collected only when cars had been held continuously by one road, and that on the transfer of the car in the ordinary routine of business to another road, a new term of use would commence at the per diem rate of 20 cts. a day.

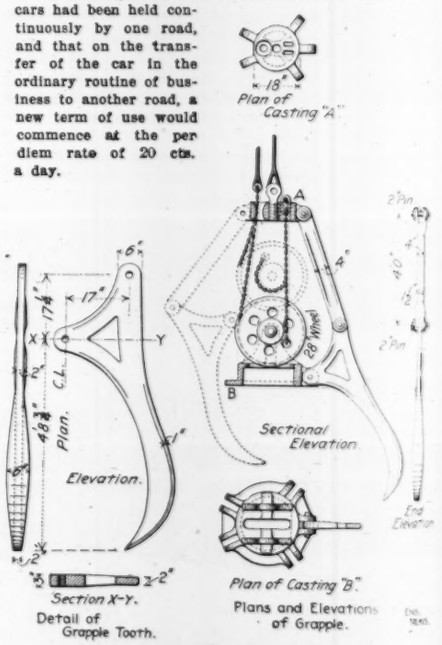


Fig. 7. Five-Arm Grapple for Large Stones.

It was soon seen that by the temporary transfer of a car to an independent branch, or connecting line, the continuity of the term of service would be broken; in other words, to use the technical term, this action would "break penalty." It was feared that some officials, who were in a position to do so, would be tempted to report upon paper the transfer of the car for the purpose of "breaking penalty" and so avoid the payment of the $1 rate, when the car itself had not been physically moved. Whether this action actually occurred or not, many believed it did, and in the absence of a direct charge, it was difficult to disprove. It was certain, however, that a large number of small independent branch roads sought

*Abstract of a paper published in the March "Bulletin" of the International Railway Congress.

†Secretary, American Railway Association, 24 Park Place, New York, N. Y.

to be admitted to the per diem rules agreement, and that their admission was generally favored by the larger lines with which they connected. This naturally gave rise to the suspicion that they were being used as places of temporary refuge for cars, that otherwise would have had to pay the penalty rate.

When the subject of the adoption of a fixed per diem rate was first agitated, there were many freight cars in service having a capacity of only 30,000 lbs. Since then, they have been rapidly replaced by larger or stronger cars, so that the average car to-day is of about 60,000 lbs. capacity, with many cars in service of 80,000 and 100,000 lbs. capacity. The average value of the freight cars in service was estimated in the committee's report in 1901 at about $500, basing their estimate upon reports received from a number of the principal lines. With their enlargement in size and the increased cost of manufacturing, owing to the rise in the price of labor and material, the cost of the cars of higher capacity ranges to-day from $1,000 to $1,300. An amount, therefore, which would compensate the owner for the use of a small car, was felt to be inadequate by the owners of these larger cars. Evidently this fact was as fully appreciated by the users of the cars as by the owners. It was recently stated that a certain great railway company had added last year to its equipment 12,000 new large capacity cars. These cars had all been shipped loaded off the company's lines, and 90% of them had never returned; so that when the statement was made, in spite

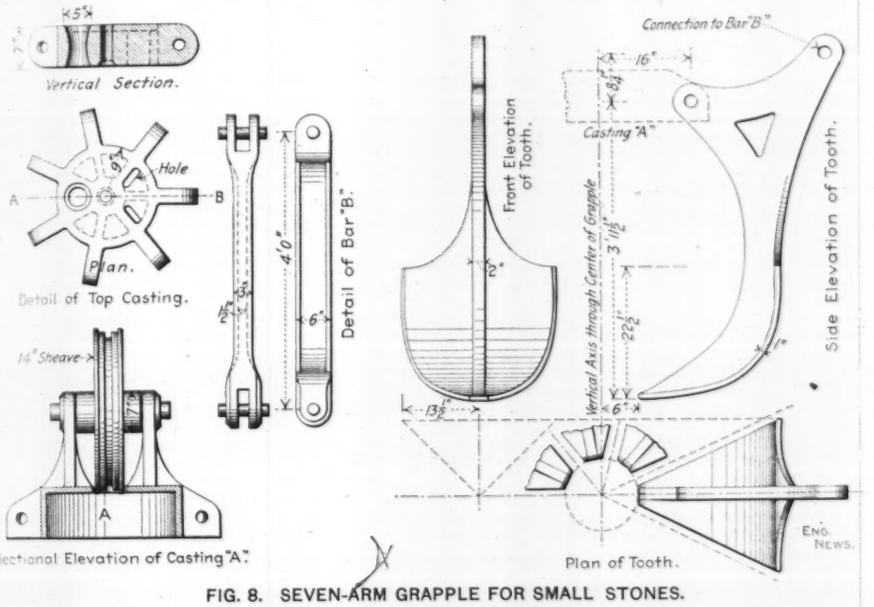


FIG. 8. SEVEN-ARM GRAPPLE FOR SMALL STONES.

of the large increase in its equipment, the company actually had upon its own lines fewer cars than a year ago. For the use, wear and tear, and interest on the cost of these cars 20 cts. a day was not an adequate compensation.

It has been estimated that the average annual cost of keeping a freight car in repair is not less than $60, and that an allowance of 5% per annum for deterioration is not too much. For a car costing $1,000, these items would amount to $110 per annum, while the maximum return at 20 cts. per day was but $73 per annum. The penalty rate in actual practice added about 2½ cts. per day to the average, making the total return $82.13 per annum against a cost of $110 per annum to the owner, without reckoning loss of interest on the investment.

Again, the owner naturally wished to retain the use of his car on his own lines, since with the enormous increase of transportation business on this continent during the last few years, traffic would sometimes be lost to the owner because there was not a sufficient number of cars on hand to handle it. The first action taken to remedy this condition was an increase in the per diem rate from 20 to 25 cts. a day which took effect on July 1, 1906, the penalty rate of $1 per day not being changed. Later in the present year, the active managers of a number of the roads, while finding themselves with an insufficient supply of cars, hesitated to recommend to their financial managers the purchase of additional equipment, since their previous action of this kind had only resulted in giving other roads the benefit of the use of the cars at a rate of charge that did not compensate the owner for the investment.

The Committee on Car Service of the American Railway Association accordingly agreed to recommend that the per diem rate should be raised to 35 cts. a day, without change in the penalty rate per day; that is, the penalty rate was to be 65 cts. per day, making $1 per day in all. Just previous to the meeting of the American Railway Association in October, 1906, the managing officials of a number of companies owing nearly half the present car equipment of the country, held a consultation and decided that a radical change in the rate was necessary. Acting upon their suggestion, the proposal for the 35 ct. rate was withdrawn, and in place of it, the question of the adoption of a rate of either 50 cts. or 75 cts. per day was substituted. This is to be submitted to a vote of the roads by letter ballot, to take effect, if adopted, July 1, 1907. In either case, if adopted, the additional penalty rate is to be entirely abolished. (This plan has now been adopted.—Ed. Eng. News.)

In the very early phases of this interchange business, a car would be shipped loaded from one road to a point on a connecting road and then be promptly reshipped to the owner either loaded or unloaded. When this practice prevailed on both roads the charges for cars were quite well equalized, and the rate being reciprocal was of little moment. As the demands of traffic increased, the return of a car empty to its owner, when a load was waiting for reshipment in an opposite direction, was seen to be an economic loss, and it soon became a common practice, under such conditions, for the waiting load to be placed in whatever car was available without regard to ownership. Since the owner of the car did not participate in this traffic by receiving any share of the receipts from freight earnings, the reciprocal character of the business was entirely lost.

This use of a freight car, under conditions to which the owner would not consent if he knew it, is termed a "diversion" and a car so used is called a "diverted car" because diverted from the reciprocal line of business in which it is supposed to be engaged. While possibly cars may be diverted in some cases as much upon the one road as the other, in still other cases manifest injustice results. The resolutions of the American Railway Association are by its constitution merely recommendatory in their character, and not binding upon any member. No adequate remedy for diversion could therefore be provided under them. The per diem rules agreement, however, was so drawn as to make the per diem rules and their amendments legally binding upon the companies which signed it. The Committee on Car Service has therefore proposed to amend these rules, and impose a fine of $5 for each offence upon the company which permits the diversion of another company's car. In order to define a "diversion," the committee formulated a set of declarations of what constitutes the proper use of a car. These have been tentatively approved by the Association and returned to the committee for further consideration and report. Considerable opposition prevails, however, to this declaration and it is by no means certain that it will be adopted. In the meantime, a number of roads that are members of the Car Hire Agreement (referred to hereafter) have decided among themselves to put into effect experimentally an agreement of a different form.

A proposition has been made to pool all the freight cars upon a basis of their number and value, and some high officials regard this favorably. Others believe that the equitable and efficient management of so extensive a business would be found impracticable. Another suggestion has been made to vary the per diem rate according to the value of the car based upon its carrying capacity, but this suggestion, although equitable in principle, would involve great difficulties in accounting. Many officials consider that this accounting would be too burdensome to make possible the practical adoption of such a plan.

Since there are now not less than 2,000,000 cars owned or controlled by American railways, the value of the service of the cars, should the new rate prevail, may be reckoned at $1,000,000 per day, if at 50 cts., and at $1,500,000 per day if at 75 cts. Payments will of course be received only for the use of cars upon lines other than those of the owner, but the value of the service will certainly not be less wherever the car may be. Half the cars owned by some companies are almost constantly off their own rails. Upon others, from one-fourth to one-third are constantly upon the rails of other roads. The proportion depends upon the character of the local and through traffic of the several lines.

In addition to the freight cars owned by the railway companies there is a large number owned by mining and manufacturing companies and other concerns, which are called "private cars." Accurate statistics of the total number of these is not available, but competent authority estimates them at about 120,000. A suggestion has been made, that in order to facilitate the use and movement of these private cars, their ownership should be merged in one general company. The payment for the use of the cars on the part of the railway companies is a matter of private contract, and is generally upon a mileage basis. They are mostly designed for a special class of lading. As they are not built for general use and for the most part cannot carry return loads, they must be returned empty to their owners.

Feeling that the situation was too acute to await the orderly action proposed by the American Railway Association, which under its practice could not put the higher rates into effect before July 1, 1907, the managing officials of a number of companies owning large equipments of freight cars called a meeting of the members of the Per Diem Rules Agreement at Chicago on Nov. 9, 1906. At this meeting where the owners of 1,400,000 freight cars were represented, it was decided, on the part of those who desired to make the rate 50 cts. per day, to form a new agreement at once among themselves. This was accordingly done, and the owners of 1,300,000 cars (about two-thirds of the entire equipment of the country), have become parties to it.

The new "car hire agreement" does not affect those who do not sign it. In other words, the members of the "Per Diem Rules Agreement" will continue to receive and to pay 25 cts. a day for the use of all cars unless they become members of the new agreement. This "car hire agreement" took effect Dec. 1, 1906, and will expire by limitation on July 1, 1907. It is assumed that by its regular methods, the American Railway Association will have raised the rate for all members of the per diem rules agreement to either 50 or 75 cts. a day on the last date above named.*

The members of the Car Hire Agreement operate about 143,500 miles of railway out of a total of 228,608 miles belonging to the members of the Association. It is of course expected by the members of this agreement that the increase in the rate of charge will have the effect of causing a more rapid handling of freight cars, and consequently their quicker relief for further service and their return to their owners. Others doubt whether this result will be realized on the ground that it will be profitable to use borrowed cars even at the higher rate, and that since the fear of the penalty rate of $1 per day has been removed, cars may be retained indefinitely.

In the meantime, the American Railway Association has appointed a committee on car efficiency which is instructed to inquire into and report upon the causes of "car shortage" (that is the lack of sufficient available freight cars) and the lessening efficiency of equipment, and to recommend remedies. This committee is authorized to employ expert assistance, and has had the sum of $20,000 placed at its disposal.

The great increase in the amount of traffic to be moved in all parts of the country is undoubtedly the primary cause of the shortage in freight cars. It has not only required the use of more vehicles of transportation, but has also caused a demand for more motive power. It has congested the tracks used for the delivery of freight. These latter were formerly amply adequate for the business to be transacted but have proved unequal to the present requirements. The extent of this increased business may be understood when it is stated that the value of the argricultural products of the country for 1906 is $500,000,000 more than for 1905. The additional wealth thus poured into the pockets of the farmers has caused an increased demand from them for manufactured articles and still further added to the volume of traffic.

Another cause for the congestion is to be found in the operation of the new railroad rate law which took effect on Aug. 28, 1906, and the interpretation that has been made of it by the Interstate Commerce Commission. Under the operation of this law, freight cars must be distributed alike to all shippers who ask for them. Formerly they were placed where the greatest amount of

*The ballot of the Association has resulted in the adoption of the 50-ct. rate, as reported at the meeting in Chicago on April 24.—Ed. Eng. News.

service could be secured from them. Every experienced traffic official will realize the delays and congestion that are involved in the application of such a regulation and the increased number of cars required to provide for it. The American railway managers have largely foreseen an increased demand for transportation and hence the enormous expenditures that have been made upon many of the lines in the construction of increased terminal facilities and additional equipment during the past year.

Car Shortage.*

In attempting to ascertain definitely the extent and location of car shortages, the committee collected information which shows that roads representing about 68% of the mileage and 79% of the cars of the country (or about 1,645,000 cars) had shortages amounting to 83,110 cars on Jan. 2, and 103,105 cars on Feb. 6, 1907. The shortages are, of course, due to lack of car efficiency, the measure of which is the number of miles per car per day. The average has been in the neighborhood of 24 miles per car per day ever since the per diem system went into effect. The latest figures, however (those for the first half of 1906), show an average of 25.4, while reports from individual roads appear to indicate that there has been no general falling off in the last six months of 1906. This tends to confirm the general opinion that the car shortages of the last six months have not been due to a lessening efficiency of the railways, but to an extraordinary increase in the demands upon them.

With the idea of ascertaining where car delays were greatest and where improvements could be made, the committee has obtained a large amount of information by correspondence, confirming the general impression that a great deal can be done to improve the situation: 1, by railways individually; 2, by railways in their relations with the public; and, 3, by the railways in their relations with each other.

1.—In the matter of opportunities for improvement by individual roads, the committee has had instances brought to its attention where improvement in facilities and practice of certain railways would not only better the situation on such roads, but improve the railway situation as a whole. It is quite evident that many roads are lacking in facilities, especially in available motive power, and that this results in congestions which hold uselessly on such lines large numbers of cars which could be usefully employed by other roads. This situation is not infrequently accompanied by an apparent lack of knowledge at headquarters, as indicated by inability of such roads to promptly report the situation. Another form of delay to which the attention of the committee has been forced is the slow unloading of material which the railways themselves own, roads in many instances appearing to enforce a more prompt unloading upon their patrons than upon their employees.

2.—In regard to the relations of the railways with the public, the committee finds that the car shortages would have been considerably lessened were the rules of the various car service associations more widely applicable and more generally enforced, as there is abundant evidence that the public delays cars more than the railways. Many of the State Commissions have approved very fair car service rules, but there is still in effect in Connecticut a law giving shippers, consignees and reconsigners 96 hours' free time, and legislation approximating this is being proposed in other States. The committee calls the attention of railways and of the public in general to the absolute necessity of an improvement in this matter. In fact, the public has it in its power, by prompt handling of equipment, to help the railways in the matter of car shortage more than they can help themselves. A general law which would prohibit any vehicle of transportation from being put to any abnormal use as a storehouse would do more to cure car shortages than any other legislation that could be devised.

3.—In considering the relations of the railways to each other, the attention of the committee has first been directed to the operation of the "Code of Per Diem Rules" of the association and the probable effect of the change in rate from 25 to 50 cts. per day, which goes into effect on July 1, 1907. The per diem system must, of course, be preserved in its present form until something better can be provided, but reports to the committee seem to confirm the impression that this system is not securing to owners of cars in times of stress either the use of their own cars or the use of an equivalent number of cars. Our information shows that for the year 1905 one group of roads was using 55% more cars than it owned. This was the extreme case for that year, so far as groups were concerned, although many single railways were using a larger percentage of foreign cars. For the first six months of 1906, this group was only using 45% more cars than they owned; a considerable improvement. When we come to Jan. 1, 1907, we find the situation with regard to this one particular group unchanged, but we find another group of roads which are using 70% more cars than they own. In summing up the matter the committee recommends:

1. That each railway, so far as is practicable, improve its own facilities, and especially its motive power available for the movement of freight. That the operating and traffic departments cooperate in improving car service and storage regulations, especially in reducing free time allowances.

2. That each railway in its dealing with the public secure all possible co-operation on the side of its customers in the prompt handling of cars.

3. That the American Railway Association reaffirm the principle as stated in the resolution passed on Oct. 24, 1906, that each railway should be assured at all times of the use of a number of cars equivalent to the number it owns. And, furthermore, that the development of this principle by the American Railway Clearing House* be approved by the Association.

*Abstract of a report presented by the Committee on Car Efficiency at the meeting of the American Railway Association in Chicago on April 24, 1907.

Car Supply and Car Pools.†

By J. W. MIDGLEY.‡

The only question really before us is: In what manner can the service be improved and insure the best results to participating railways? Two methods seem to find most favor: 1, a limited car pool, car exchange, or car clearing house; and, 2, an equipment company to comprise a special description of freight cars and operate them on the principle of the Pullman Car Company, with the notable distinction that it should be controlled by interested railways and not by individuals. It may be said that current events have pushed the last proposition to the front, and it can now be safely asserted that an equipment company to operate refrigerator cars in the interest of railway companies is not only possible but extremely probable.

The demands of business will necessitate the employment of cars regardless of marks or ownership, so that those rules which provide for the loading of equipment in the home direction will be in practice, as heretofore during congested periods, be honored more in the breach than in the observance. Of what use, under those circumstances, to call attention to the neglect of this obligation, and to advise that executive officers be induced to instruct that the aforesaid regulations be duly regarded?

Careful observers freely assert that there are freight cars enough at the disposal of railroads to satisfactorily handle the business of the country during its most crowded state, if those could be used in common. It follows, then, that the real trouble is not owing to lack of cars, but to their imprudent employment. Under the operation of per diem, eastern roads no longer send cars west in large numbers to await loading when the new crop begins to move. Initial roads have to provide cars in which to forward the freight they originate. Furthermore, connecting lines expect such cars to run through to destinations, which, in the case of grain, are principally North Atlantic ports. Instead of loading such equipment in the direction of home, as required by the car service rules, it has been declared that in most instances during the busy season, eastern lines divert western cars into local trade. The result necessarily is to deprive those roads which preponderate in the origin of through traffic of a proper quota of cars with which to transact their local business, so that the latter suffers, and the enterprise of companies in providing additional modern high-capacity cars to care for increasing tonnage is frustrated. It was in recognition of complaints as above that an eastern superintendent advocated an exchange of cars on an equalized tonnage basis. In other words, he recognized that if a western road should deliver a number of loaded standard box cars, then enough empties should be tendered in exchange to supply an equal amount of tonnage capacity. His plan contained an element of justice that should commend it to careful consideration; but it is not apparent how the arrangement could be made effective between independent roads unless its direction were confided to a joint agent. The idea partakes of the clearing principle, and whenever that enters, its application should be devolved upon a disinterested party.

A car pool would equalize the car exchange upon a tonnage basis. A 40,000-lb. car is not worth as much as a 60,000-lb. or an 80,000-lb. modern car; but one cannot but marvel at the persistency with which objectors put forward this obstacle, yet continue to exchange car for car at the same rental regardless of its value, capacity or description, and make no effort to change the rule in that respect. Obviously, a costly refrigerator car or a high-capacity box car is worth more than a flat car or an antiquated, under-sized box car. I repeat this now, because of the frequent recurrence of the objection. It does not apply to the kind of car pool I have advocated. A limited pool of box cars between a few parties would begin with a standard car. Each party would contribute its quota of cars, and the exchange or rental could be adjusted on a tonnage capacity. The ideal basis would be 1 ct. per ton; then a 60,000-lb. car would command 30 cts. per day, an 80,000-lb. car 40 cts., and so on. In that event, the necessary material to repair such cars would be kept in stock, and, as far as practicable, the repairs and renewals would be made by the pool.

*This is an association of railways which have voluntarily organized to operate a car-pooling system.
†Abstract of a report made in October, 1906.
‡Chicago, Ill.

Car Performance.*

By C. C. RILEY.†

There are two ways of increasing the performance of cars, which is equivalent to increasing the car supply, one by heavier loading and the other by promoting movement. Under present practices freight equipment is idle eleven-twelfths of the time and busy one-twelfth. The excessive time allowed for loading and unloading retards the movement of a large percentage of freight equipment. It has been suggested that by reducing free time to 24 hours, after placing and increasing the demurrage rate, the available equipment of the country will be greatly increased.

The one remedy proposed, which will most likely be given a trial, is the pooling of equipment. If the car pool were universally adopted the advantage would be with the line that owns a sufficient number of cars to transact its business, as under the provision of the pool it would be entitled to as many cars on its line at all times as it had in the pool. The borrowing lines would be the sufferers. It is from this source that the benefits would accrue, as the roads which do not own a sufficient number of cars in which to handle their business would be required to procure them.

While a recognized car pool will be advantageous and will facilitate distribution of cars, the evils now complained of will not be corrected, except as to the number of cars added to the pool. At the season of the year when there are the greatest shortages, all the cars in the country are not sufficient to supply the demand, and it would be a great injustice to railroads if they were compelled to provide themselves with all the freight cars necessary to move the business of this country during that period, as it would necessitate the expenditure of millions of dollars for cars which could be used only a few months each year. The rest of the time they would remain idle. Since the establishment of a per diem the equipment of all railroads has practically been pooled, but the distribution has been unequal, as the receiving road usually has all the cars needed while the originating road suffers the shortages.

It is a question whether railroads exercise their best judgment in building their equipment upon the single basis of carrying capacity instead of on the double basis of cars and carrying capacity. Too many high-capacity cars have been built in recent years, as shown by the small average load; and in view of the fact that there have been relatively few changes in classification. In order to demonstrate the truthfulness of this as related to box cars, some figures were prepared covering the business of the busiest months of the Erie Ry., and it was found that, exclusive of merchandise, the average load placed in a 60,000-lb. car was 15 tons; in a 70,000-lb. car, 21 tons; in an 80,000-lb. car, 21½ tons.

It will be noted that the average load would utilize less than half of the carrying capacity of the 40-ton box car, and about two-thirds carrying capacity of the 30-ton box car. During the last fiscal year, the Erie Ry. handled 1,120,000 loaded box cars. Of this number 470,000 were loaded with merchandise, which averaged 12,000 lbs. a car, and 650,000 were loaded with freight other than merchandise, which averaged 41,000 lbs. If the Erie Ry. could have had its choice of 30-ton cars or 40-ton cars, in which to handle all freight requiring box cars, during the last fiscal year, a saving of $312,000 would have been effected in the cost of operation by the use of the smaller car, the lesser weight of the smaller car making this possible. Heavy capacity cars are operated economically when used for handling specified commodities of great specific gravity, such as tidewater coal and ore.

The Freight Car Problem.‡

One of the causes of congestion at terminals is the reconsignment privilege granted on many of the principal articles of freight. This is of great value to shippers, but it is manifestly unjust that the consignee at the terminal should be unable promptly to receive his freight because traffic that is destined elsewhere encumbers yards and tracks. This is not a slight nor an insignificant cause for the slow movement of freight and shortage in car service, and it appears readily possible for the railways and shippers to remedy this condition if they will.

A considerable body of this traffic never should require reconsignment. It has become a practice on the part of many shippers to bill their freight to a reconsigning point as a matter of convenience to themselves without respect to its necessity. This may be checked by the shipper, or the railways may discourage it by the imposition of a reasonable reconsignment charge or

*Abstract of a paper read before the New York Traffic Club in February, 1907.
†Superintendent of Transportation, Erie Ry., Jersey City, N. J.
‡Abstract of a report by the Interstate Commerce Commission, Washington, D. C.

by limiting drastically the time allowed on reconsignment. On the railways may (and the reason for such a plan is becoming emphasized more strongly every day at all of the larger terminals) provide separate terminals outside cities at which freight may be held pending determination by the shipper as to destination.

There is, it would appear, little necessity for so extensive a time limit for unloading as is often granted. The grain elevators at Chicago promptly met the charge that they were to blame for car shortage by reason of delays in unloading by showing from their books that over 90% of the cars delivered to them were emptied the day of delivery, and that all their cars were unloaded within 48 hours, thus indicating that an allowance of greater time than two days was unnecessary. The coal men, who were allowed five days free time, conceded that an allowance of 48 hours would be reasonable.

If it be true that any considerable part of the shortage of car service from which the country is suffering is due to the excessive and unnecessary time allowed by railways, it is manifestly within the power of the railways themselves to correct such abuse. If through fear of losing traffic to each other or through indifference or inability they do not enact and enforce the needed rules, they will not be able reasonably to object should power to make such rules be vested elsewhere. It is to be preferred that the railway managements should regulate themselves in such matters rather than impose the task upon the government, and it is to be hoped that they will promptly find a way to do so.

The most generally advocated remedy for the failure on the part of carriers to furnish cars when demanded is that now generally known as "reciprocal car demurrage." This means that carriers shall be penalized upon failure to furnish cars demanded, and the phrase arises out of the universal railway practice of imposing a per diem penalty when a car is held for unloading beyond a certain fixed number of days. It is to us evident and beyond all controversy that the difficulties with which the business of transportation is affected in this country at the present time would not be overcome by the enactment of a reciprocal demurrage bill alone, if such measure merely provided for punishing the railroad for non-placing of cars or non-movement thereof. The problem is one much deeper and much broader than a mere lack of cars and engines. No doubt an inadequate supply of these facilities is the cause of all the troubles which beset the shipping public on certain lines. But these instances are few. The problem of car shortage is one in which is involved every factor in railroading—the construction, the operation, the maintenance, and the financing of the railroads. The inability of the shipper to secure a car may be a symptom of a deep-seated and organic trouble.

Manifestly it is of little value to a shipper to be given a car if that car, when loaded, is not moved promptly to destination. Therefore the conclusion is inevitable that reciprocal demurrage alone will not insure better railroad service when the movement is over more than one system of railroad. Such a law or rule must be supplemented by some other rule or law under which the originating carrier may be insured of prompt return of the cars which it delivers to its connections. When the railroad is penalized for not placing a car at a shipper's warehouse or elevator it will protect itself against the loss of that car by refusal to permit it to pass beyond its control unless it can be given another car in its stead, or unless some system is devised similar to that of the car pool, under which its needs for cars may be promptly met.

While it has been found that perhaps all of the roads whose representatives appeared at this hearing are suffering from an inability to supply cars promptly, it has not been demonstrated that, taking all roads together, there is an actual shortage of cars for the service required. It is the contention of men most conversant with existing equipment that there is a sufficient supply of both cars and locomotives to meet present demands, were such a plan adopted as would permit a free interchange of cars between railways, and an arbitrary and common control of all equipment in its handling and distribution. This is the plan suggested by John W. Midgley of Chicago, and is commonly known as the car pooling scheme, or more properly the car clearing house. Its successful operation involves difficult problems, but with a realization of the imperative need for some system by which the activity of cars can be stimulated it is idle to say that the proposed plan could not be made effective.

THE STONE BREAKWATER AT CLEVELAND, O.

By GEO. H. CUSHING.*

The United States Government engineer at Cleveland, Lt. Col. Curtis McD. Townsend, has recommended to the Chief of Engineers a modification in the form of construction of the stone masonry portion of the breakwater at Cleveland, and also at Lorain and Ashtabula. The recommendation is of more than local importance,

Fig. 1. Breakwater at Cleveland, O., at Concrete Pierhead. After Storm of October, 1906.

because it promises to have a big influence on breakwater construction, at least on the Great Lakes, inasmuch as it overcomes many of the difficulties experienced heretofore, and promises to provide a harbor protection free, to a remarkable extent, from the dangers of settling.

The majority of such structures on the lakes have been, and still are, built of timber. It has been only a few years since the increasing price of timber forced the government, in this section, to use stone or concrete. When the first breakwaters in this territory were built, timber was the cheapest material, being abundant in the lower lake region, and especially abundant in the upper peninsula of Michigan and in the Lake Superior territory. Improved transportation facilities permitted the carrying of upper lake timber to the lower lake ports, and its sale at such a low price made it out of the question, from an economic standpoint, to use anything else. In consequence the old style of breakwater was built of timber cribs, which were towed to place, sunk and filled with stone. On top of these a timber superstructure was built with a vertical face. The old sub-structures were protected by the water, and many of them are still sound, and in good order. The superstructure, however, decayed rapidly, and after 15 or 20 years had to be replaced.

During the administration in Cleveland of Col. Jared A. Smith, U. S. A., it was necessary to replace the superstructure, first on the east arm of Cleveland breakwater, and subsequently on the west arm of the breakwater. When the work had to be done on the east arm Colonel Smith recommended the substitution of a slanting for a vertical facing, with a view to modifying the force of the blow of the waves. When it became necessary to replace the superstructure on the west arm of the breakwater concrete was substituted for timber, the latter material having increased so rapidly in price that concrete was cheaper. The same form of construction was then used in concrete, a modification being made to the vertical facing.

THE RUBBLE MOUND ADDITION.

Toward the close of the administration of Colonel Smith it was decided to extend the east arm of the breakwater eastward by about four miles. The project was of great importance, and Colonel Smith worked on the plans for a couple of years. He finally made a recommendation to the Chief of Engineers that the timber substructure be used, and a concrete superstructure be imposed upon it. A board of engineers of the United States Army was appointed to revise these plans, and it was suggested then that since both timber and concrete were expensive, the government might be able to make a stronger and more permanent breakwater, as well as one having a lower cost, by the use of stone almost exclusively. Up to that time only two rubble-mound breakwaters had been used on the Great Lakes. One of them was built at Petoskey and the other was just being started at Buffalo. There was really no criterion by which to go as far as the force of lake waves was concerned, and the work was experimental to a certain extent. After he had drawn the plans, which were accepted by the board of engineers, Colonel Smith was transferred, and the actual construction of the breakwater was left to Dan C. Kingman, Colonel of Engineers.

Following the recommendation of the Board of Engineers, he started to build the first 1,000 ft., with the outer and inner foundations of the new stone breakwater in the form of ridges of stone. It was provided that each one of these stones should weigh not less than 100 lbs. and up to 300 lbs. The space between was filled with sand. Since the top of the sand pile would not come within 12 ft. of the mean level of the lake, it was believed that the waves would not disturb this material at that depth. The first winter the ridges were constructed and sand was exposed to the waves to determine the effect. It was found, in the spring, that a portion of the sand had been removed. This proved that the exertion of the waves was felt at a greater depth than was thought possible.

It was the intention originally to place a core of furnace slag upon this sand-bed, the same

FIG. 2. VIEWS SHOWING EFFECT OF STORM OF OCTOBER, 1906, ON STONE BREAKWATER AT CLEVELAND, O.

*1150-55 Old Colony Building, Chicago, Ill.

to be covered over with a rip-rap of small stones and to be paved with stones not less than 2½ ft. thick, and weighing not less than three tons. It was found that the furnace slag was impossible to obtain, since the railroads were using that material for ballast. In consequence the engineers were forced to substitute shale, and this was covered over with a rip-rap of small stones, and paved as per the original intention.

The engineers have come to two conclusions

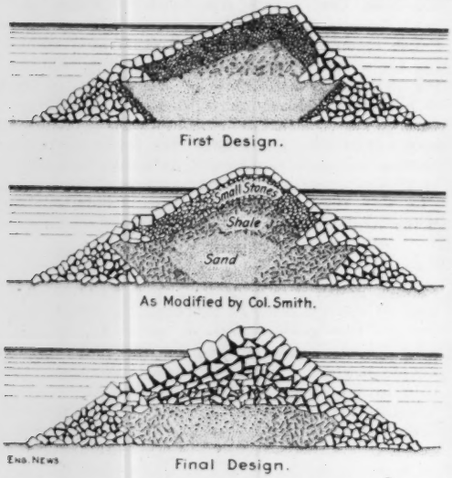


Fig. 3. Sections of Stone Breakwater at Cleveland, O.

in this connection. One is that the paving stones have not been large enough, and that laying them to place has been a mistake in policy as far as service is concerned. The use of shale is now declared to be a mistake, in view of the fact that it is more susceptible to settling. These conclusions have been arrived at, partly as a result of the work already done on Cleveland breakwater, and partly as a result of disclosures in connection with the Buffalo and Petosky breakwaters. In Petosky it was found that paving stones weighing one ton, and placed on a slope of one to three, were lifted by the action of the waves, and carried entirely over the rubble mound. In Buffalo it was found that following a storm,* on Dec. 10, 1902, sections of the breakwater settled from ten to fourteen feet. In Cleveland the settlement has been only a few inches, and this following the storm of October 20 to 27, 1906.

The action of that storm disclosed some of the weaknesses of the present form. It was found that the blow of the waves on the sea-facing of the breakwater was of sufficient force to act as a piston, and drive the paving stones on the opposite side entirely out of place. The smaller stones and the shale, weighed down by the heavy material on top, naturally oozed out through the opening made, and permitted a settling of the entire structure. This displaced some of the paving stones on the facing toward the lake, and in some instances permitted the lowermost stone to slide entirely off its foundation. This permitted a still further settling of the entire structure. In some instances the force of the waves was sufficient to change the general line of the breakwater, by forcing it in toward the shore as much as a foot or more. Figs. 1-2 show the breakwater after the storm had damaged it. The engineers have come to the conclusion that the paving stones have not been heavy enough in the first place, and that the core of the breakwater has not been of sufficiently strong material.

Instead of the use of sand in the future, it is proposed to use altogether the run of the quarry. The refuse and the smaller stones will, of course, be placed at the bottom, and the stones will gradually become larger as the surface is approached. It is proposed that, in future, the foundation ridges shall be composed of stones weighing not less than one ton, while the paving stones shall be not less than three tons, and run up to six tons or more, according to the wish of the contractors. Instead of being laid to place, these stones will be set with their greatest dimensions toward the core of the breakwater. In addition the use of larger stones will permit a steeper facing, and the incline will be probably one to two.

It is apparent that since stones will not have to be quarried with such care, the material will be much cheaper, and by using the quarry waste instead of shale or slag, it is expected the cost of completing the east arm of the breakwater in Cleveland will be lessened by at least $50,000. At the same time the saving to the contractors will be twice that amount, since they will be able to make greater headway with the work, and will get more money for their material. In the old form the necessity to lay the stones to place on a rip-rap of small stones required calm weather for work. The rip-rap of stones under the new form will be less liable to disturbance by storms, and placing the paving will not be such a difficult task.

*See Engineering News, March 19, 1903; also proceedings American Society Civil Engineers, Vol. 52, pp. 136-7, and discussion, pp. 198-214.

AN ELECTRIC BLUE-PRINTING MACHINE FOR UNIT FRAMES.

By F. LINCOLN HUTCHINS.*

In some branches of work it is often necessary to reproduce a great many small drawings of such size and number as to make the use of a continuous artificial light blue-printing machine undesirable. It is also somewhat inconvenient to print from a number of small tracings in one large frame. To solve the difficulties of winter conditions in some work of this sort the arrangement here described was adopted as a substitute for the more expensive commercial machine.

In the first place a standard size of prints is used, namely: 8 × 10 ins. and hence provision for this size was alone required. Light was obtained from an ordinary direct electric current by means of an enclosed (clear glass) multiple arc lamp of 230 volts and from 2½ to 3 amperes. Ordinary photographic printing frames, 8 × 10 in. in size, are used to hold the tracing and printing paper.

Mounted upon a tripod, having an arbor at its apex, is a ten-sided drum with flaring sides, having a hub with wooden rolls, upon which it revolves around the arbor; in this drum are ten apertures the size of the inner face of the printing frames. A rabbeted extension at the bottom holds the lower part of the printing frame while a brass spring engages and holds the top of same.

Fitting on to the lower drum is a similar one with receding sides, but without the [illegible]nsion and the springs, as the frames remain [illegible]ed on account of their position.

Thus provision is made for 20 fra[illegible] each one equi-distant and at the same angle [illegible]m the lamp, which is suspended and proje[illegible] down through a hole in the upper drum and [illegible] centered by means of a plummet over th[illegible] center of the arbor on the top of the tripods. [illegible] distance from the center of the flame to th[illegible] center of the glass in the printing frame is 22 ins.

Fig. 1. An Electric Blue-Printing Machine for Separate Frames.

With fairly heavy plotting paper 15 minutes is ample printing time and a boy is kept nearly continuously employed in putting in and taking out the blue-print paper, the frame revolving with advantage to the process. Ordinary tracing paper prints very much faster and the 20 frames are too many to keep going in case quick printing paper is used.

The washing of the prints is usually undertaken after the printing is finished.

The accompanying photograph shows the machine sitting in a comparatively dark place, as it is used, and was taken by using the light from the arc lamp alone.

There seems no reason why a modification of form would not permit the printing of long and narrow prints; for instance, a drum might be made with straight sides, not too wide for the light, and provided with an expansible band at the top and bottom inside of which could be placed a celluloid strip. Between this and the side of the drum the drawing and blue-print paper could be placed and the bands tightened to make proper contact. It might be necessary to turn the drum to equalize the light and obviate the shadows.

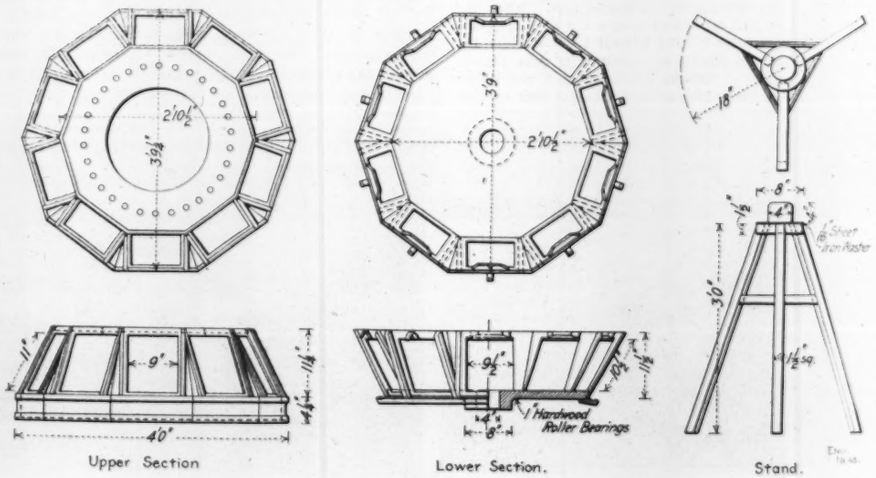


FIG. 2. DETAILS OF AN ELECTRIC BLUE-PRINTING MACHINE.

*Carl Harrington Emerson, Consulting Engineer, Topeka, Kan.

NEW RAILS FOR THE CHICAGO STREET RAILWAYS.

The extensive work of the reconstruction and general improvement of the street railways of Chicago will be commenced within a short time. This work will be done by the companies to meet the requirements of the city, and under the direction of the Board of Supervising Engineers, representing both the city and the companies. The chairman of this Board is Mr. B. J. Arnold, M. Am. Soc. C. E., who has for some time been the city's consulting engineer in regard to the traction question; Mr. Charles V. Weston, M. Am. Soc. C. E., has been appointed as the city's representative on the Board, and Mr. Harvey B. Fleming represents the Chicago City Ry. Co.

In the track system a grooved girder rail of 129 lbs. per yd. is to be used, and is shown in the accompanying cut. This form of rail was determined upon by Mr. Arnold, and was adopted by a city ordinance passed Oct. 8, 1906. The type of track construction, however, is subject to the approval of the new Board of Supervising Engineers, and has not yet been definitely adopted. This new rail is 9 ins. high, 6 ins. wide on the base, and 5¼ ins. over the head. The actual width of tread is comparatively narrow; it has a slight inclination towards the groove, and the outer edge of the head is beveled off, although it would seem that a square-cornered head closely fitted to the paving would make a better street surface. The groove is 1¼ ins. deep, with a flaring guard, and the top of the guard or lip is ¼-in. below the level of the top of the tread.

The contract for these rails has been awarded to the Lorain Steel Co., of Lorain, O., and we give below an abstract of the specifications for their manufacture. It is to be noted, however, that the paragraphs relating to variations in size (2) and to the details of rolling (4, F) were approved by Mr. Arnold only for the first 5,000 tons, in order to obtain sufficient rails for commencing the work. During the manufacture of this first lot the inspector representing the Board of Supervising Engineers will make special observations of that part of the work covered by the paragraphs noted, and the Board may require a revision of these paragraphs for the remainder of the order.

SPECIFICATIONS FOR RAILS FOR CHICAGO STREET RAILWAY TRACKS.

1. Type.—The rails are to be of the grooved-girder type.

2. Section.—The section of the rail shall conform to the specification contained in the revised municipal code of Chicago, as amended by ordinance passed Oct. 8, 1906. A variation in height of 1/64-in. under or 1/32-in. over that specified, and 1/16-in. total variation in width of base only will be permitted, except that 5% of the first 5,000 tons may be furnished with a total variation in width of base of not more than ¼-in. The section of rail shall conform perfectly to the fishing dimensions.

3. Weight.—The weight will be maintained as nearly as possible (after complying with paragraph A) at the specified weight of 129 lbs. per yd. A variation of 0.5% for an entire order will be allowed. Rails shall be accepted and paid for according to actual weight.

4. Process of Manufacture.—A. The entire process of manufacture and testing shall be in accordance with the best current practice, and special care shall be taken to conform to the following instructions:

B. Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled, or until the metal in the interior has time to solidify.

C. No bled ingots shall be used.

D. Sufficient shall be discarded from the top of the ingot to insure sound rails.

E. Care shall be taken to avoid overheating the steel, and under no circumstances shall a "cinder" heat be allowed; that is, a heat high enough to cause the cinder to run off the steel as it is being drawn from the furnace. This does not apply to cinder which may be sticking to the underside of the steel when drawn from a horizontal furnace, or to the bottom of an ingot when drawn from a soaking pit.

F. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass, the temperature of the rail will be the same as the temperature of the 141-lb. rail rolled for the Philadelphia Traction Co. But this temperature shall in no case exceed 2,000° F. (this clause to apply to the first 5,000 tons of present order only).

5. Chemical Composition.—Rails shall conform to the following limits in a chemical composition:

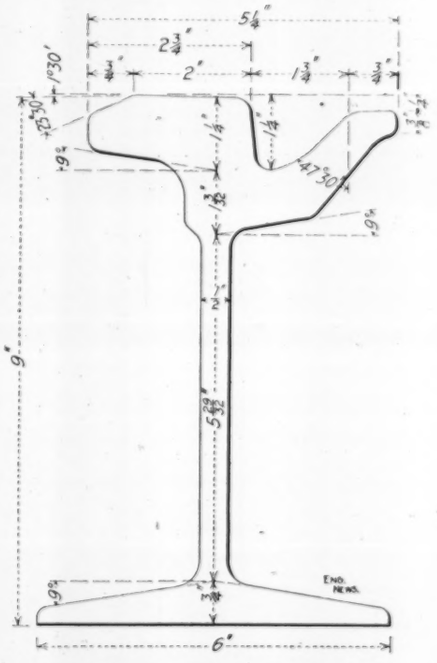
Carbon (Ave. 0.55%)	0.50 to 0.60%
Sulphur not to exceed	0.08%
Phosphorus not to exceed	0.10%
Silicon not to exceed	0.20%
Manganese	0.80 to 1.10%

6. Tests.—A. One drop test shall be made on a piece of rail not less than 4 ft. and not more than 6 ft. long, selected from each fifth blow of steel. The test piece shall be taken from the top of the ingot. The test rail shall be placed head upward on the supports and shall be subjected to the following impact test under a free falling weight, the height of drop to be 20 ft. If any rail breaks when subjected to the drop test, two additional tests may be made of the other rails from the same blow of steel, also taken from the top of the ingots. If either of these latter rails fail, all the rails of the blow which they represent will be rejected. If both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted.

The drop testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins., and the test rails shall be placed head upward on solid supports 3 ft apart. The anvil block shall weigh at least 20,000 lbs. and the supports shall be part of, or firmly secured to, the anvil. The report of the drop tests should state the atmospheric temperature at the time the test was made.

B. Instead of the drop test, the following may be substituted at the inspector's option: While the heat is being cast, two test ingots shall be made, the first from steel going into the first regular ingot, the other from metal representing the last one. These test ingots, shall be 3 × 3 ins. and not less than 4 ins. long. From these, bars at least ½-in. square shall be drawn at one heat by hammering. Each bar, when cold, shall be bent, without breaking, to not less than a right angle. Should one bar from a heat fail, and the other stand the test, a third bar may be taken from a bloom rolled from the ingot represented by the failed one. If this stands the test, it shall be accepted in place of the failed one. If the manufacturer choose, more than the two test ingots may be taken, but they must be from the steel of the first and last regular ingots. If this is done and a test bar fails, another one may be drawn from the duplicate ingot and tested, and, if it stands, accepted.

7. Length.—The rails shall be 56 ft. and 58 ft. in length, with 20% of shorter lengths in multiples of 1 ft. down to 35 ft. Rails to be paired as to lengths before shipment.



Section of 129-lb. Grooved Girder Rail for Chicago Street Railways.

8. Drilling and Punching.—Drilling and punching specifications shall be furnished to the manufacturer from time to time, and will include joint-bolt holes, tie-rod holes, and brace-bolt holes. All holes shall accurately conform to the drawings and dimensions furnished in every respect, and must be free from burrs.

9. Finish.—The rails must be free from all mechanical defects and flaws, and shall be sawed square at the ends, and the burrs made by the saws carefully chipped off, particularly under the head and on top of the flange. They shall be smooth on the heads, straight in line and surface when finished, without any twist, waves or kinks, particular attention being given to having the ends without kinks or drop. No. 1 rails shall be free from injurious defects and flaws of all kinds.

10. Straightening.—Care must be taken in hot straightening the rolls of the rails so that gagging under the cold press will be reduced to a minimum and so applied that the rails will not be made lumpy. The distance between supports of rails in the gagging press shall not be less than 40 ins.

11. Branding.—The name of the maker, the weight of the rail, and the month of the year of manufacture shall be rolled in raised letters and figures on the side of the web, and the number of blow shall be plainly stamped on each rail where it will not be subsequently covered by the splice bars.

12. Inspection.—The inspectors representing the railway company, or the Board of Supervising Engineers, shall have free entry to the works of the manufacturer at all times while this contract is being filled, and shall have all reasonable facilities afforded to satisfy them that the rails are being made in accordance with these specifications. All tests and inspections shall be made at the place of manufacture prior to shipment. The manufacturer shall furnish the inspector daily with the carbon determinations of each heat and a complete analysis every 24 hours, representing the other elements contained in the steel. Such analysis shall be made from the average drillings taken from test ingots.

The inspectors shall have authority to reject rails from insufficiently sheared blooms, or from heats the test pieces of which have failed, or from badly poured heats, or from chilled heats, or from bled ingots. The rails made from insufficiently cut blooms, if otherwise perfect, to be afterwards received as No. 1 short rails, if after sufficient lengths they have been sawed off, to make them conform to specifications, they shall exceed 35 ft. in length. By "badly poured" heat is meant one which from any cause has been "teemed" without the control of the operator. A "chilled" heat is one which by reason of the chilling of the steel has to be either pricked or poured over the top of the ladle. A "bled" ingot is one from the center of which the liquid steel has been permitted to escape. Imperfectly drilled, straightened (except lumpy rails), or chipped or filed rails shall be rejected, but will be accepted if subsequently properly finished. Rails failing to comply with the requirements of paragraph No. 2 will be rejected.

13. No. 2 Rails.—Rails that possess any injurious defects, or which from any cause are not suitable for first quality, or No. 1 rails, shall be considered No. 2 rails. Provided, however, that rails which contain any physical defects which impair their strength or usefulness and fail to comply with the requirements of paragraph No. 2, shall be rejected, and rails rejected under the drop test will not be accepted as No. 2 rails. Both ends of all No. 2 rails shall be painted white in order to distinguish them. No. 2 rails will be accepted up to 10% of the whole order, at a reduction of $2 per ton in price below that specified in the contract.

ELECTRIC EQUIPMENT FOR THE DETROIT RIVER TUNNEL.

The traffic on the Michigan Central R. R. tunnel now being built under the Detroit River between Detroit and Windsor will be operated by electric locomotives. The length of line thus operated will be 4.6 miles, and will comprise with the yards about 15 miles of single track. The progress of work on the tunnel was noted in our issue of May 9. Six 100-ton direct-current locomotives, with geared motors, will comprise the initial equipment for handling both freight and passenger trains. Each locomotive will be capable of hauling a 900-ton train up a 2% grade at a speed of 10 miles per hour. Four 280-HP. motors will be mounted on each locomotive, two motors being placed on each truck. The Sprague-General Electric multiple-unit control system will be used, enabling the locomotives to be operated singly or in pairs.

Power for operating the system will be purchased from the Detroit Edison Co., and will be delivered to a substation at Detroit at a potential of 4,400 volts, and at a frequency of 60 cycles. At the substation two 1,000-KW. synchronous motor-generator sets will be installed for supplying direct-current to the third rail. Each of these sets will consist of a 1,000-KW., 4,400-volt, three-phase, synchronous motor, direct connected on a common base to a 1,000-KW., 650-volt, compound-wound, direct-current generator. A 15-KW., 125-volt exciter for the synchronous motor will be mounted on a shaft extension of each of the motor-generator sets. At the substation a storage battery will be provided to carry the fluctuations of the load, and if the main power supply should be interrupted this battery can operate the entire system for half an hour. In such an emergency, the lighting and pumping equipment will be energized by 60-cycle, alternating current from a 50-KW. motor-generator set, the driving motor being supplied with current from the storage battery. All the electrical equipment will be furnished by the General Electric Co.

A very complete electric lighting and electric pumping equipment forms a part of the project. The yards and approaches to the tunnel will be lighted by arc lamps, while the tunnel will be illuminated by incandescent lamps arranged on duplicate circuits, so arranged that half the lamps in both tunnels will burn if either of the circuits should be broken. Alternating current from the main power supply at a frequency of 60 cycles will be used on the lighting circuits. A single three-phase distributing circuit will run through each tunnel and from these circuits suitable connections will be made to step-down transformers. The secondaries of the step-down transformers will be interconnected with duplicate circuits for half the lamps in each of the tunnels.

For keeping the tunnel dry, five sumps will be provided, each drained by induction-motor centrifugal pumps arranged in duplicate. The motors on the pumps will operate directly at 4,400 volts, and the controlling circuits with compensators will be centralized in the substation. For indicating the amount of water in each sump, a float system will be provided, having both visible and audible indicating devices in the substation.

DETERMINING THE DIRECTION OF DEEP BORE HOLES AND TESTING THEIR WATER TIGHTNESS.

In bringing the new water supply from the Catskill Mountains to New York City a difficult problem is encountered in carrying the great aqueduct across the Hudson River. The valley of the Hudson is an ancient geological gorge which has been eroded to great depth, particularly in its lower section. At New Hamburg, where it was first proposed to cross the river, bore-holes were made to great depth without finding solid rock. It has therefore been decided to continue the aqueduct on the west side of the river on south for a dozen miles or more to the entrance of the Hudson highlands.

Here it is expected that solid rock will be encountered beneath the river bottom, and it is proposed to sink in the rock on either bank of the river vertical shafts, some 500 ft. more or less, in depth. Before driving a tunnel to connect the bottom of these shafts it is necessary to know that the rock to be penetrated is not fissured and water-bearing, so as to admit water from the river above and make the driving of a tunnel through it impossible. It is proposed, therefore, to make diamond drill borings from each shaft half way across the river preliminary to starting the tunneling operations.

In making long borings, either horizontally or vertically, with diamond drills, however, it is now known that the drill deflects very much from a straight course. It is necessary, therefore, to determine the true position of the drill-hole.

An instrument and method for effecting this has been devised by Mr. John J. Horan, of the engineering staff of the Board of Water Supply, and an illustration of it is shown herewith in Fig. 1. The instrument consists of a brass casing

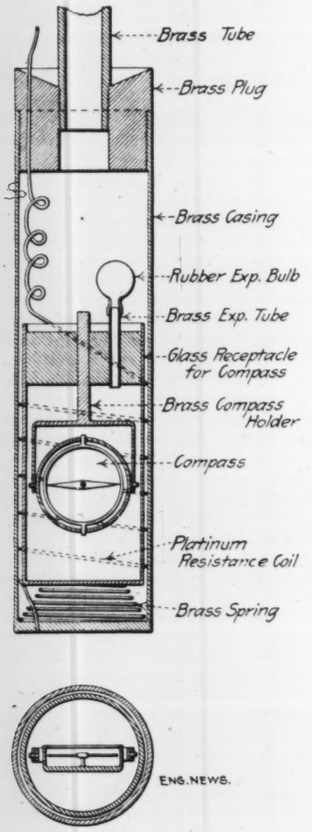


Fig. 1. Instrument for Determining Direction of Deep Bore Holes.

in which is placed a closed glass cylinder containing gelatin or paraffin wax and having a compass mounted on gimbals suspended in it. A coil of resistance wire surrounds the glass jar. The whole apparatus is lowered to the bottom of the bore hole by the drill rods and a current is passed through the resistance wire. The heat melts the paraffine and the compass box assumes a horizontal position while the needle points to the north. After the paraffine wax cools and solidifies, the compass box and needle is held fast in position and the whole instrument is raised to the surface.

Instead of using an electric current to melt the paraffine, hot water may be pumped down through the hollow drill rods, to be followed by cold water to solidify it; or ether or other volatile liquid might be poured into the hole and allowed to settle about the compass, and later vaporized by applying a suction pump to the drill rods.

Fig. 2 shows the apparatus devised by Mr. Horan for measuring the indications of the instrument removed from the bore hole. It contains graduated vertical and horizontal arcs provided with verniers which are used to measure the horizontal and vertical deflection which the compass and its box has suffered.

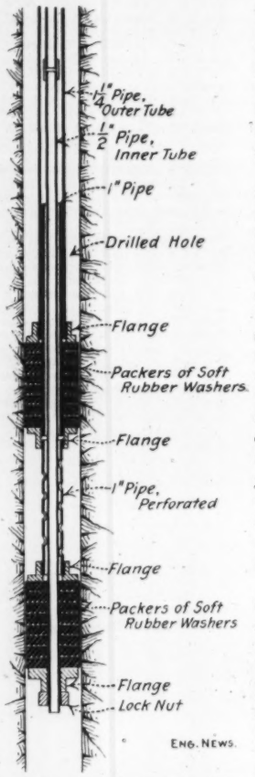
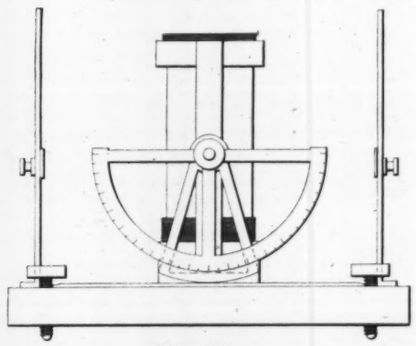


Fig. 3. Apparatus for Testing Porosity of Rock Penetrated by Bore Holes.

As some of our readers may recall, Mr. Horan's instrument in Fig. 1 resembles in many respects



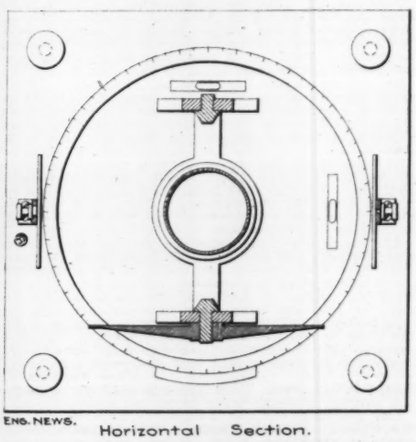


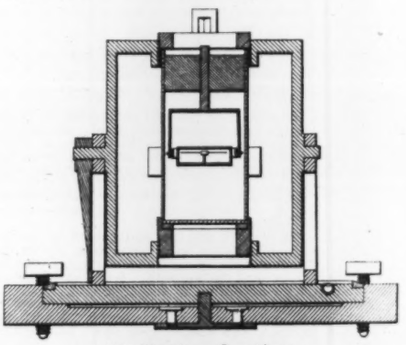
FIG. 2. APPARATUS FOR RECORDING INDICATION OF BORE HOLE INSTRUMENT.

one designed by Mr. Hugh F. Marriott, an English engineer, in a paper read by him [illegible] 16, 1905, before the Institution of Mining and Metallurgy and printed in our issue of July [illegible] 1905. In both cases a compass suspended in wax which is melted by an encircling electric coil and is afterward allowed to solidify, is the apparatus adopted to record the position of the hole.

In Fig. 3 we illustrate an ingenious device, also developed by Mr. Horan, for testing the water-tightness of diamond-drill bore-holes. It has been used in the preliminary surveys to determine the solidity of rock to be penetrated by inverted siphons to carry the proposed aqueduct across deep valleys encountered in its route. It consists, as shown in the cut, of a string of soft rubber disks strung on a tube and held between metal washers. Above these rubber disks is a larger tube. The two tubes with the rubber washers at their lower end are lowered down the drill-hole and at any desired point the coupling connecting the inner and outer tubes above ground is screwed up until the rubber disks are compressed and expanded to make a tight joint with the sides of the bore-hole. Water is then forced into the space in the bore-hole around the outer tube, and the extent of the leakage from the bore-holes, if any, is determined.

A modification of this instrument has also been devised and is illustrated in Fig. 4, by which a section of the hole between two sets of packers may be tested for tightness. The test is made by forcing water into the space between the inner and outer tubes. The same apparatus may also be used to test the tightness of the hole below the lower packer. To do this water is forced through the inner tube into the space below the bottom of the lower packer.

In this case should the lower packer happen not to plug the hole completely, as, for example, should it be located at a longitudinal seam which would allow water to pass it, any such leakage would fill the space between the two sets of packers and come to the surface through the outer pipe. Should there be a leak in the inner tube, water would also come up through the outer tube.



PRESSED STEEL SEPARATORS for I-beams and channels are being introduced by the Kellogg Iron Works of Buffalo, N. Y. These separators are of the same contour as the cast-iron ones hitherto used, and have the same spacing of bolt-holes, but they are considerably lighter. They are made of flange steel, in the following thicknesses:

Depth of beam,	6 and 7 ins.	1/8-in.
	8, 9 and 10 ins.	5/16-in.
	10 to 20 ins.	1/4-in.

The Carnegie standard spacing of bolt-holes is used. In making these separators, the bolt-loop (or loops) is first formed by pressing in a die, and then the contour of the separator is cut to accurate shape and size by cutting-dies. These steel separators are to be furnished in quantity to the hardware dealers, in large cities, so that they can be obtained for any piece of steelwork as quickly as the bolts. This is to replace the prevalent custom of ordering separators from the foundry only when ordering the steel, which often involves troublesome delay and confusion. Besides elimination of delay, the advantages of lower cost, no breakage and no blind holes are claimed for them. Mr. C. H. Kellogg, of Buffalo, N. Y., has patented these steel separators.

THE CORROSION OF STEEL IN REINFORCED CINDER CONCRETE.

By WILLIAM H. FOX.*

The subject of reinforced cinder concrete and the inherent danger in its use through the liability of its reinforcement to corrosion, seem to have been investigated but little, and even in recent years have received but meager attention.

Prof. S. L. Norton, expert in charge of the Insurance Engineering Experiment Station, Boston, has made numerous experiments to determine the corrosion of steel in various concretes,† among them cinder concrete. His first experiments were with perfectly clean steel; later the tests were repeated, using steel in various stages of initial corrosion with the same results as shown in the case of chemically clean steel. From his experiments, Prof. Norton concludes that in order to prevent corrosion in cinder concrete, the concrete should be a wet mixture and mixed thoroughly. He states that with this precaution, he would trust cinder concrete quite as well as stone concrete, in the matter of corrosion.

In a report of a committee, read before the Structural Association of San Francisco,‡ it was stated that after having examined the ruins left by the great fire, the committee found in many cases that metal which had been encased in cinder concrete had corroded. In their opinion it was possible, though not probable, that this corrosion was due to the presence of sulphur in the cinders. The amount of corrosion found was so great that the committee advised a revision of the building laws, so as to exclude the use of cinder concrete.

In view of these conflicting opinions and the small amount of available data on the subject, it seemed to the writer an excellent field for investigation, and was undertaken as a graduating thesis from the Thayer School of Civil Engineering.

In these experiments, Portland cement (Helderberg brand) was used in all cases. Four different mixtures were used, the proportions being as follows:

By volume.	By weight.
1 : 1 : 3	1 : 1.2 : 1.5
1 : 2 : 5	1 : 2.4 : 2.6
1 : 2½ : 5	1 : 3.0 : 2.6
1 : 3 : 6	1 : 3.6 : 3.1

Three variables, in regard to the method of mixing, were introduced, namely, dry and tamped, wet and untamped, and wet and tamped. The dry mixture was of such a consistency that water flushed to the surface only after a vigorous tamping, and the wet mixture was such that water was running from it continuously, while mixing.

The cinders used were the usual steam cinders, procured from the local heating plant. The coal used in this plant is one of the better grades, containing but a trace of sulphur. These cinders were screened through a ¾-in. screen, all material passing this screen being rejected. The largest size was probably not over 2½ ins. The steel specimens, 5-in. long and 1-16-sq.-in. in cross-section, were procured by cutting up expanded metal, and straightening the pieces; three being used in each concrete specimen. In a few cases, round steel rods were used, but on account of the difficulty in grinding them, their use was discontinued. Immediately before mixing a batch of the concrete, the steel pieces were thoroughly ground on an emery wheel and every particle of rust removed.

The molds were made of ¾-in. pine, inside dimensions 4x4x9-in., this allowing a covering of 2-in. in all directions—the minimum depth of covering used in practice. The backs of these molds were hinged, and one end fastened with bolts, to facilitate removing the specimens. Three 1-in. holes were bored in the front face of each mold, through which the steel protruded, so that an opportunity was afforded on each specimen for a comparison of the corrosion on the exposed portion, with that on the part protected by the concrete. In all, twenty blocks of concrete were made, each containing three steel pieces; this gave a total of sixty test pieces of steel.

As these experiments were made in winter, the sand and water used were heated, since the cold materials, by retarding the setting of the cement, might allow a free access of water or steam to the steel (as described later) and so vitiate the experiments. In mixing, the sand was first spread evenly, and the cement thoroughly mixed with it. This mixture of sand and cement was then formed into a ring, and the screened cinders placed in the center. Water was then poured over the cinders until they would absorb no more; the dry sand and cement from the outer part of the ring was then spread over the wet cinders, more water added, and the whole mass thoroughly mixed. In the tamped specimens, the molds were half filled with the concrete and thoroughly tamped; then the steel placed in position, the molds filled, and tamped as before.

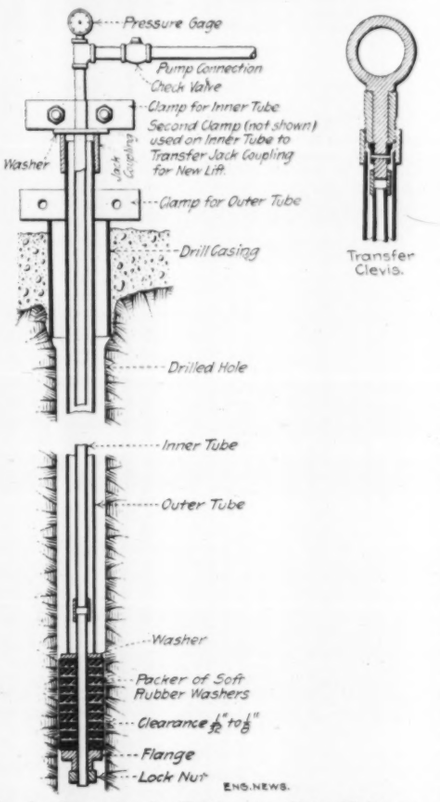


Fig. 4. Apparatus for Testing the Water-Tightness of Any Section of a Deep Bore Hole.

After remaining 24 hours in the molds, the specimens were removed.

On removal from the molds, a collar of neat cement was placed around each piece of steel where it protruded from the concrete, so in case the bond between steel and concrete was not good, this collar would prevent water from working along the steel pieces and corroding them in the interior of the concrete. This method was adopted because Prof. Norton's experiments have shown that steel will not corrode when imbedded in neat Portland cement. The specimens were then placed either in the steaming-box or in water. The steaming-box was merely a covered, zinc-lined box, with a loosely fitting door; it was provided with an inlet connected to the steam reservoir of a heater, and was large enough to contain four specimens. As the steam escaped freely into the air, these specimens were merely in a steam bath at atmospheric pressure. They remained in the steam bath during twelve hours each day for two weeks; at the end of this time they were removed and others substituted. In all, the steamed specimens had five weeks of this treatment. Those specimens intended for water treatment were placed in a tank, allowed to soak for 24 hours, then removed and allowed to stand in the air for 24 hours, so they were alternately soaked and dried.

On placing the specimens in water, air bubbles were noticed rising to the surface of the water, the action continuing for some minutes. This, showing the presence of voids in the concrete, led to a determination of the percentage of water absorbed in 48 hours as follows:

Proportions.	Mixed.	Percentage by wt water absorbed.
1 : 1 : 3	D & T.*	2.2
	W & U.	3.0
	W & T.	4.5
1 : 2 : 5	D & T.	3.6
	W & U.	6.5
	W & T.	2.7
1 : 2½ : 5	D & T.	5.1
	W & U.	5.9
	W & T.	2.8
1 : 3 : 6	D & T.	4.3
	W & U.	7.8
	W & T.	6.2

*D & T = dry and tamped; W & U = wet and untamped; W & T = wet and tamped.

An examination of the specimens before breaking, showed that in the untamped specimens, the sand and most of the cement had fallen to the bottom, while the cinders with but a thin coating of cement had risen to the top. In looking for the reason of this, it was quite evident that this settling out of the aggregate was due to the difference in specific gravities of the ingredients. An average of five determinations of the specific gravity of the cinders used, was found to be 1.5. Since the specific gravity of sand is approximately 2.7 and of cement is about 3.0, the reason for this settling out is evident. This, in the opinion of the writer, is a sufficient reason for thoroughly tamping all cinder concrete.

After about forty days' treatment, the specimens were broken, and the steel carefully examined for corrosion. With but one exception, one or more of the three steel pieces in each specimen, showed unmistakable signs of corrosion. Apparently it made no difference how the concrete was mixed—wet or dry, tamped or untamped; whether the steam or water treatment was used, the result was the same—rust streaks and spots were found; the difference in the amount of corrosion being imperceptible. The exception noted above was the "dry and tamped" 1:1:3 mixture, which showed all three pieces of steel entirely free from corrosion. As this, however, was a single specimen (through lack of time, the "dry and tamped" specimens were not treated with steam), it can hardly be accepted as proof that this mixture and method of treatment will always give a rust-proof cinder concrete. In regard to the protection afforded by neat cement, in no case was any evidence of corrosion found underneath the collars of neat cement which surrounded a portion of each steel specimen, as previously described.

Although it is difficult to draw any broad or general conclusions from such a limited set of experiments, they seem, nevertheless, to indicate a few general considerations, which may be of value. To secure a dense homogeneous cinder concrete, a thorough tamping is necessary. A rich mixture, either a 1:1:3 or one in which the proportion of cement to aggregate is larger, should be used in all cases. The greatest of care should be taken in mixing the materials, and it may be necessary to resort to the seemingly impractical method of coating the reinforcement with grout before placing in the concrete.

While these experiments are severe and of short duration, they are intended to give results approximating those under actual conditions, of long duration. However, in such buildings as dye-houses, foundries and some manufacturing establishments, where certain rooms are frequently filled with steam; in hotels, office buildings and like structures, where after the floors have been washed, the water is liable to percolate through the concrete—in such cases the treatment which these specimens received in the laboratory is very nearly realized in actual practice.

These experiments and their results have been given in detail, in the hope that others will see the necessity for further investigation. Until further experiments have been made along these

*Wilder, Vt.
†Engineering News,, Vol. 51, p. 29.
‡Engineering News, Vol. 56, pp. 458, 461, 549, 661.

lines, it is quite evident that cinder concrete should be used only with a view toward the possibility of future corrosion.

AN ITALIAN BALANCED-COMPOUND PASSENGER LOCOMOTIVE WITH CAB IN FRONT.

A peculiar design of locomotive which has been developed in Italy and introduced extensively on the Adriatic lines of the Italian State Railways has the boiler reversed, with the firebox and cab at the front end of the frame and the smokebox and cylinders at the rear end. Since the government took over possession of the railways a few years ago, a large number of locomotives have been ordered to bring the motive-power equipment up to modern conditions, and these engines include several of the design above mentioned. The accompanying illustrations represent a four-cylinder balanced-compound passenger engine of this class, of the ten-wheel or 4-6-0 type, built by the Societa Italiana Ernesto Breda, of Milan. About 25 of these are now in service. The illustrations are reproduced from "The Engineer," of London.

It will be seen that the four cylinders are all placed in line beyond the smokebox, and are inclined to enable the connecting rods of the inside (high pressure) cylinders to clear the rear driving axle. The Laird type of crosshead is used, with a single guide bar above the piston rod. The driving axles are hollow steel forgings, and the crank axle is square in section and bent obliquely between the two cranks. The two piston valves on each side are operated from a single valve gear of the Walschaert type; the high-pressure valves give inside admission through crossed passages, while the low-pressure valves give central admission direct through double-end piston valves. The steam chests of each pair of valves are connected by 1½ in. pipes in order to maintain a uniform pressure.

arch, as shown. The smokebox is very long (6.56 ft.) and the base of the smokestack extends within it in the form of a draft pipe. The elbow arrangement of the low-pressure exhaust pipe is necessitated by the position of the cylinders. The cab has side doors, and on the right (or fireman's) side is a coal bunker with capacity for four tons of briquettes. The driving wheels have semi-elliptic springs (of inverted camber) placed beneath the boxes and connected by equalizers. The truck is of the swing link type, the movement being controlled by helical springs at the ends of the bolsters. The Westinghouse brake is fitted to the driving and truck wheels. Fig. 1 shows a sectional plan and elevation of the engine and Fig. 2 shows partial cross-sections.

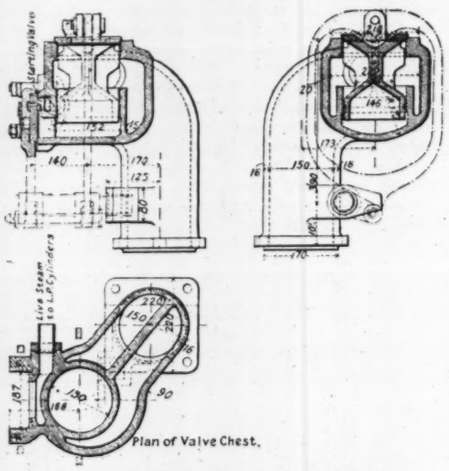


Fig. 3. Throttle Valve for Graduated Opening.

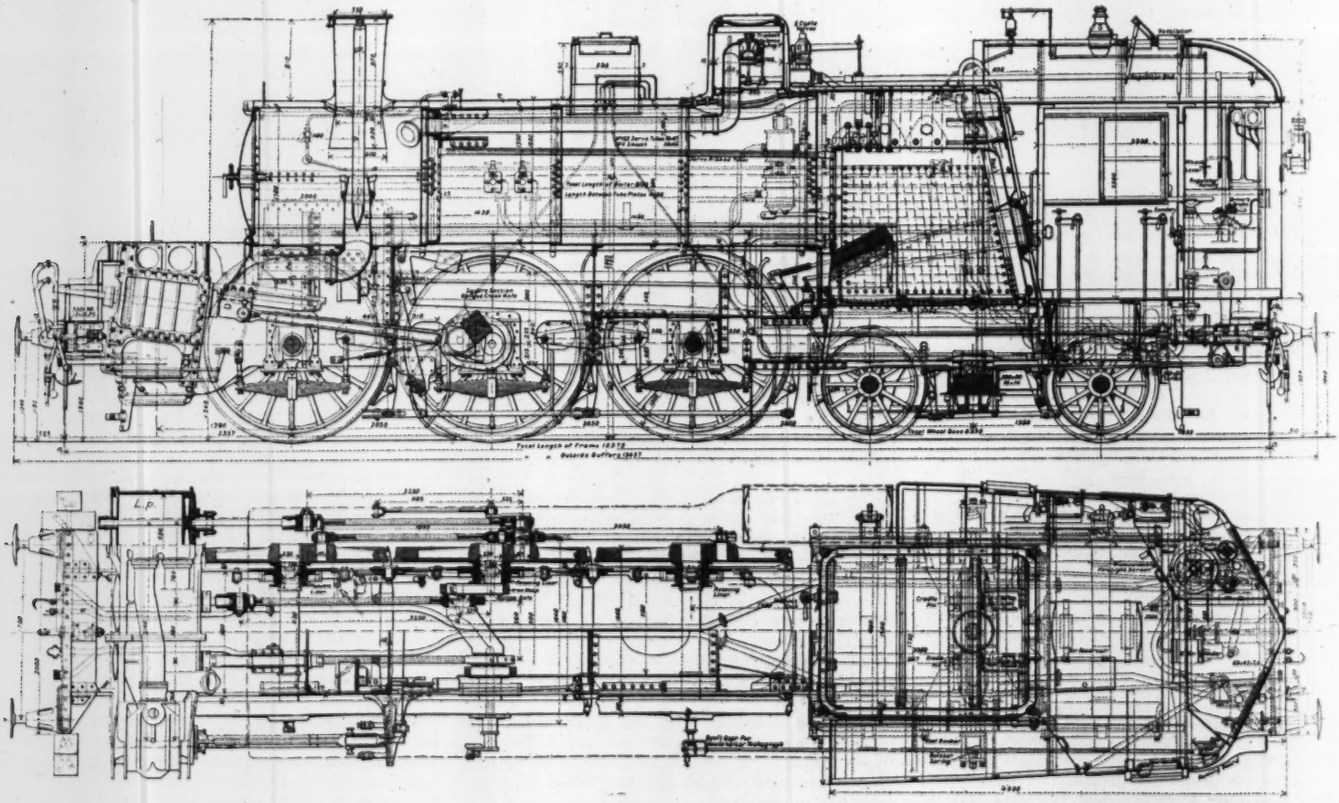


FIG. 1. SECTIONAL PLAN AND ELEVATION OF TEN-WHEEL FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE: ITALIAN STATE RAILWAYS.

The boiler is of the wagon-top type, with a large dome mounted on the wagon top, just beyond the firebox, which is of the Belpaire type, made with sloping head. No fire-door ring is used, but the plates are flanged and riveted together at this opening. The firebox is shallow, placed above the frames, and has a firebrick

THROTTLE VALVE.—The tri-phase balanced regulator (throttle) is of the ordinary cylindrical type, but with only one instead of two seats, as in the American patterns. Its purpose is to avoid certain inconveniences of the double-seated valve in which the balanced or differential pressure on the two ends is such that leakage is possible and the valve may occasionally be lifted without the regulator handle (throttle lever) being touched, unless, as is becoming usual, the handle is provided with a spring bolt working in a notched section. With the balanced valve there is also the difficulty of graduating the opening of the valve when starting. As soon as the valve is lifted from its seat, the minimum opening which it is possible to give by hand valves of this type (which are rarely less than 6 ins. diameter) at once corresponds to a considerable displacement of a flat valve, the port of which is very often of a triangular shape, to render the increase in sectional area gradual. Besides this, there are constitutional difficulties in fitting the valve on its two seats. On account of the possibility of unequal expansion of the valve and the body casting it is usually sought to reduce this trouble by shortening the distance between the two seats as short as possible, and by casting the head and the valve from the same melt.

The valve proper, Fig. 3, is a combination of a drop-seat valve with a piston valve, the one above the other. The admission is from the top only, and the whole pressure of the steam bears against the single-beat valve. The first movement of the throttle lever is to operate a small valve which admits steam into a closed chamber below the sliding portion of the valve. This piston valve does not fit tightly, and the annular clearance allows a part of the steam to escape to the throttle pipe and valve chests, the other part remaining in the chamber for the purpose of balancing the pressure on the single-beat valve. This is termed the first period of the three-phase valve, for starting a train without slipping the driving wheels. The limit of this period can be felt through the regulator handle just when the stop on the small valve encounters the underside of the loose-fitting piston valve. By continuing the upward motion, the single-beat valve is unseated, but as its cone extends down below the seating the full sectional opening of the valve is not attained until that cone is raised clear above the top of the seat. This is termed the second period, its purpose being to accelerate slowly the speed of the pistons without slipping the wheels. When the valve is raised so much that the lower side of the conical portion is level with the top of the seat, the third period is entered, and thenceforward the action does not differ from that of ordinary balanced valves in the progressive increase of steam volume admitted to the valve chests.

The small valve by which steam is admitted below the lower face of the valve is either a small auxiliary flat valve, or else a small valve formed by the vertical rod which lifts the valve, this rod being turned to form a miniature piston in a cylindrical part of the valve proper. In the compound locomotives under consideration the former arrangement was found to be simplest, since the auxiliary flat valve for supplementing the pressure in the low-pressure valve chest, when starting, was already there. The arrangement will be understood from the

longitudinal section in Fig. 3. There are in use some 200 or more locomotives fitted with this regular valve, which, besides its steam-tightness and gradual opening, is said to be easily made and economical to maintain. It admits steam only at the highest point in the throttle pipe (which in low domes is an advantage), and it is said to render unnecessary the employment of relief valves for the automatic discharge of water from the cylinders.

FLEXIBLE AXLE BOXES.—A new feature in the axle-boxes of these locomotives is the provision of articulations between the axle-box and the pedestal guides, by means of which the driving and coupled axles are free to tilt obliquely under shocks due to the irregularities of the track, or otherwise permit the vertical axis of the locomotive to shift freely upon the riding springs, without these relative displacements disturbing the regular and continuous seating of the axle-box upon the whole length of the journals or imparting any torsional strains to the pedestals. This arrangement, Fig. 4, simply amounts to a radial axle-box arranged for vertical instead of horizontal displacements. The rounded edges of the axle-box liner constitute a pivot around which the axle-box is free to turn in a direction transverse to the locomotive. The resulting action is, to some extent, comparable to that of spherical axle-box crowns. These circular axle-box liners, introduced by Mr. G. Zara (the designer of the Valtellina Ry. electric locomotives) were subjected to tests on the earlier compound locomotives, the results being such as to induce their application in all the newest engines of this type.

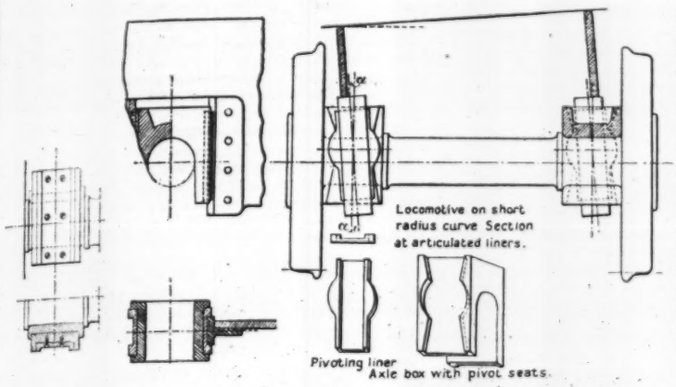


FIG. 4. FLEXIBLE AXLEBOX FOR ITALIAN LOCOMOTIVE.

PERFORMANCE.—In service the work done by these engines is exceptionally good. In fast accommodation trains (a service generally admitted to be more difficult than non-stopping runs) they are required to pull trains up to 450 metric tons, which is equal to five times the weight of engine and tender in average condition of gross load. Omitting the tender as a quantity too variable for permitting the mechanical efficiency of a locomotive to be expressed in this manner, this weight is 6½ times the maximum weight of the engine with its four tons of coal. A calculation of the average power developed in a long period of regular work, covering a distance of 187,000 miles, shows that the fuel consumption was 2.62 lbs. per I. HP.-hour, the coal used being briquettes made from Cardiff slack averaging in thermal value (by calorimeter tests) 7,300 B. T. U. This fuel evaporates 7 lbs. of steam in ordinary boilers carrying lower pressures, and from 8.8 lbs. to 9.2 lbs. of steam per lb. of coal in the boilers of these compound locomotives. The coal economy is remarkable as it applies to an average of three months' service in all conditions of daily working.

The principal dimensions of these interesting locomotives (which are designed for a maximum speed of 80 miles an hour) are given in the appended table.

TABLE OF PRINCIPAL DIMENSIONS ITALIAN COMPOUND-BALANCED LOCOMOTIVES.

Driving wheels (6)		6.30 ft.
Truck wheels (4)		3.60 "
Wheelbase:	Driving	13.45 "
	Truck	8.40 "
	Total	27.00 "
Length over buffers		44.07 "
Weight of engine, in working order		70.50 tons.
Weight of tender: Empty, 16 tons; loaded		36.00 "
Cylinders, h. p. (2)		14.4 × 26 ins.
Cylinders, l. p. (2)		23.6 × 26 ins.
Boiler, diameter of barrel		4.97 ft.
Smokebox, length		6.57 "
Firebox:	Length	6.62 "
	Width	4.92 "
	Height above grate	4.81 "
Tubes (Serve ribbed), 125; diameter		2¾ and 3 ins.
Tubes, length		13.12 ft.
Heating surface:	Tubes	2149.63 sq. ft.
	Firebox	120.83 " "
	Total	2270.46 " "
Grate area		32.28 " "
Smokestack:	Diameter	26.0 ins.
	Height above smokebox	32.4 ins.
	Height above rail	13.91 ft.

FIRE TESTS OF DRY POWDER FIRE EXTINGUISHERS.

Two publications of recent date deal with "fire extinguishers" of the dry-powder class, and serve to further illuminate the question as to what degree of utility resides in such devices. The most definite statement concerning such extinguishers was contained in Mr. John R. Freeman's exhaustive Presidential address before the American Society of Mechanical Engineers in 1905, "The Safeguarding of Life in Theaters,"* where the subject was necessarily discussed because the stage of the Iroquois Theater at the time of its disastrous conflagration was provided with dry-powder extinguishers to the exclusion of water pails. In that address several sets of analyses were presented which showed that all such extinguishers contain bicarbonate of soda, with a little coloring matter and usually some substance intended to prevent caking of the powder. Bicarbonate of soda is decomposed by heat, yielding carbon dioxide and sodium carbonate, the latter a quite stable substance; the carbon dioxide gas, by displacing the atmospheric oxygen necessary for combustion, is relied upon to extinguish the fire upon which the powder is thrown. Whether this action is of such degree as to afford much protection against fires is a matter to be determined by actual test. Mr. Freeman's discussion expressed the opinion, very definitely, that while "the material has some small value for a certain class of fires," it is not recommended for use in factory fire protection nor about the stage of a theater. "Pails of water are far more reliable."

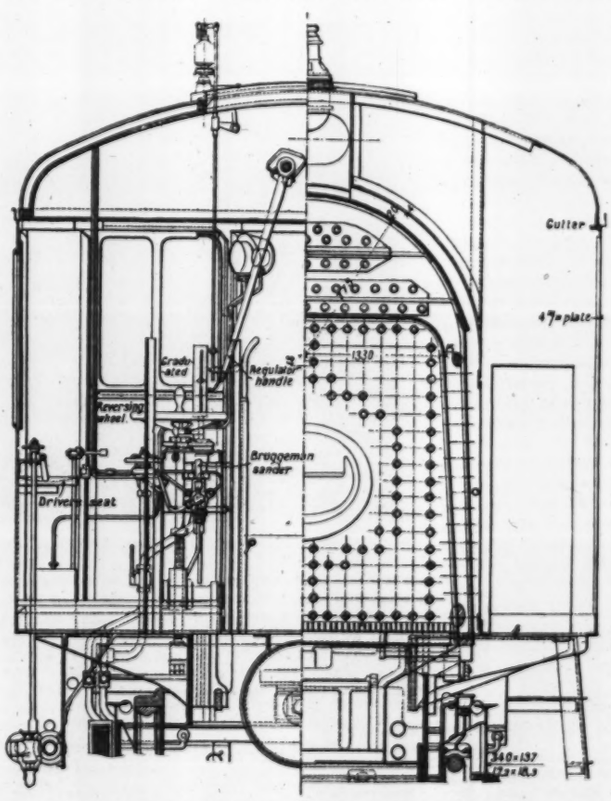


FIG. 2. CROSS-SECTIONS THROUGH FIREBOX AND FRONT CAB.

Some further evidence as to the usefulness and reliability of dry-powder extinguishers is contained in a committee report† of the British Fire Prevention Committee and in Bulletin 125‡ of the National Fire Protection Association.

The British Fire Prevention Committee made a series of fire-extinction tests with an extinguisher sold under the name of "Kyl-fyre," upon application of the makers of the latter. This is sold in two sizes: Large, a sheet metal tube 2¾ ins. diam. by 20 ins. long, holding 5 lbs. of powder; Small, a tube 2⅜ ins. diam. by 20 ins. long, holding 3½ lbs. of powder. These tubes are hung on a hook in the wall, and for use are pulled with force away from the hook, whereby the cap of the tube is pulled off, and the contents of the tube are then thrown "into the base of the flame."

Tests were made as follows: (1) On a bedroom dressing-table, with curtains above and the usual amount of inflammable material about. In one test the curtain, in another the paper in a waste-basket were ignited, and allowed to burn 40 sec. before the extinguisher was applied. One small extinguisher put out the flames, but smoldering had to be knocked out eventually. (2) A crate of excelsior was lighted and allowed to burn 20 and 30 secs. in two tests. The extinguisher subdued the flames, but smoldering continued and fire repeatedly broke out again, so that finally water was used. In one test four large tubes, in the other five large and three small tubes were used. (3) A heap of hay, straw and wood scraps, burning for about 35 secs., gave results similar to those under head (2), requiring the application of water finally, after six large tubes had been used in each test. The result was the same in the corner and in the center of a room. (4) Fifty to one hundred wooden lath were set slanting against a metal wall, while beneath was an armful of hay sprinkled with gasolene. The hay was allowed to burn 45 to 70 secs. in different tests. Two to four large tubes of extinguisher were used. Smoldering material had to be stamped or knocked out finally. (5) An armful of hay and straw in a structure like a hayrack was lighted underneath and allowed to burn for 30 sec. Six large extinguishers failed to control the fire against breaking out afresh, so that finally water was applied. (6) A heap of celluloid shavings and chips, about 15 ins. diam. by 9 ins. high, allowed to burn for 7 to 10 sec., practically burned itself out in spite of the application of 3 to 4 large tubes. (7) A heap of oily rags and cotton waste, about 30 × 30 ins., after burning 90 sec. was completely put out by one extinguisher. (8) Two-thirds of a pint of "petrol" (gasolene) sprinkled over a wood floor 6 × 6 ft. and immediately lighted were extinguished in 3 sec. by one large tube of extinguisher.

The bulletin of the National Fire Protection Association cites two tests, which duplicate two of the above, though the results differ somewhat: (1) Gasolene was spread on a wood surface 4 × 7 ft. and allowed to burn 5 sec. Three tubes of extinguisher subdued the blaze, but fire flared

*Reprinted nearly in full in Engineering News of Dec. 14, 1905, pp. 624-630.

†Obtainable from the British Fire Prevention Committee, 1 Waterloo Place, Pall Mall, London, England, at 2s. 6d.

‡Apply to W. H. Merrill, Secretary, 382 Ohio St., Chicago, Ill.

up again in a few seconds. Sufficient powder was added to cover completely the whole surface, but the gasolene burned without being appreciably retarded thereby. (2) A heap of wood, hay, shavings and excelsior, about 3 × 3 ft., was allowed to burn 3 mins., and then the contents of 9 tubes of extinguisher were thrown on. The fire was retarded to some extent, but in four minutes was burning rapidly again, though completely covered with the powder.

It must be remembered, in connection with the tests quoted, that any value that dry-powder extinguishers may have is doubtless much reduced by caking of the powder in the tubes, as proper spreading of the powder over the seat of the fire is then much less likely to take place. In this connection we note that the bulletin last quoted states, on the authority of the Underwriters' Laboratories, Inc., that "on examination of 31 tubes of various makes, stored since 1903-1904 in a basement protected from the weather, it was found that 11 were caked to such an extent as to prevent their use."

ALCOHOL AS A SOURCE OF POWER.

On account of the greatly increased interest in alcohol utilization, due to the recent passage of a law making it possible to produce denatured alcohol in small farm distilleries, the subject of power production from alcohol is discussed in a bulletin (Farmers' Bulletin No. 277) recently issued by the U. S. Department of Agriculture. The authors, Prof. C. E. Lucke, of Columbia University, and Mr. S. M. Woodward, of the Department of Agriculture, discuss first the relative cost of the available fuels, in which connection they give two tables, one of which is reproduced herewith. The interesting figures of these tables show that alcohol is a far more expensive fuel, on the basis of equal amounts of heating-power, than any other, even when it is sold at prices as low as 30 cts. per gallon. To furnish a heat unit as cheaply as gasoline costing 15 cts. per gallon, alcohol must be sold at not more than 10 cts. per gallon. The table which we reproduce, giving the expenditure for fuel needed to produce one horse-power hour, puts this comparison into more directly useful figures, when considering alcohol as a source of power. It shows that the farmer can produce a horse-power hour on less than 7 cts. worth of alcohol, costing 40 cts. per gallon, whereas a small steam plant will burn over 2 cts. worth of coal for the same output. The elements of attendance, repairs, trouble, etc., all of which are much greater in the small steam plant than in the alcohol power plant, are not taken account of in this table.

The main part of the bulletin is taken up with a lengthy discussion of the internal-combustion engine, bearing specially on the points affected by the differences between gasoline and alcohol. The discussion makes it clear that any gasoline engine can be used with alcohol, but also states that better performance is obtained from an engine designed specifically for alcohol, or a gasoline engine modified in certain parts (the carbureter and the combustion chamber, to secure fuller vaporization and much higher compression of the charge) to suit the use of alcohol. It is noted particularly that while in Germany the design and production of alcohol engines has been very active, American engine builders are almost totally indifferent to the demands and possibilities of the new field.

A concise summary of the facts and comparisons brought out by the authors is stated in their conclusions, the principal ones of which are as follows:

Any engine on the American market to-day, operating with gasoline or kerosene, can operate with alcohol fuel without any structural change whatever, with proper manipulation. The different designs of gasoline or kerosene engines are not equally well adapted to the burning of alcohol, though all may burn it with a fair degree of success.

Alcohol contains approximately 0.6 of the heating value of gasoline, by weight, and in the Department's experiments a small engine required 1.8 times as much alcohol as gasoline per horse-power hour. This corresponds very closely with the relative heating value of the fuels, indicating practically the same thermal efficiency with the two when vaporization is complete. In some cases carbureters designed for gasoline do not vaporize all the alcohol supplied, and in such cases the excess of alcohol consumed is greater than indicated above. The thermal efficiency of these engines can be improved when they are to be operated by alcohol, first by altering the construction of the carbureter to accomplish complete vaporization, and second, by increasing the compression very materially.

An engine designed for gasoline or kerosene can, without any material alterations to adapt it to alcohol, give slightly more power (about 10%) than when operated with gasoline or kerosene, but this increase is at the expense of greater consumption of fuel. By alterations designed to adapt the engine to new fuel this increase of power may be made about 20%. Because of the increased output without corresponding increase in size, alcohol engines should sell for less per horse-power than gasoline or kerosene engines of the same class.

Storage of alcohol and its use in engines is much less dangerous than that of gasoline, as well as being decidedly more pleasant. The exhaust from an alcohol engine is less likely to be offensive than the exhaust from a gasoline or kerosene engine, although there will be some odor, due to lubricating oil and imperfect combustion, if the engine is not skillfully operated.

It requires no more skill to operate an alcohol engine than one intended for gasoline or kerosene. There is no reason to suppose that the cost of repairs and lubrication will be any greater for an alcohol engine than for one built for gasoline or kerosene. There seems to be no tendency for the interior of an alcohol engine to become sooty, as is the case with gasoline and kerosene. With proper manipulation, there seems to be no undue corrosion of the interior due to the use of alcohol. The fact that the exhaust from the alcohol engine is [illegible] as that from gasoline and kerosene engines [illegible] indicate that there will be less danger from [illegible] less offense in a room traversed by the exhaust [illegible] and less possibility of burning the lubricating oil. [illegible] latter point is also borne out by the fact that the exhaust shows less smokiness.

In localities where there is a supply of cheap raw material for the manufacture of denatured alcohol, and which are at the same time remote from the source of supply of gasoline, alcohol may immediately compete with gasoline as a fuel for engines. If, as time goes on, kerosene and its distillates become scarcer and dearer by reason of exhaustion of natural deposits, the alcohol engine will become a stronger and stronger competitor, with a possibility that in time it may entirely supplant the kerosene and gasoline engines. By reason of its greater safety and its adaptability to the work, alcohol should immediately supplant gasoline for use in boats. By reason of cleanliness in handling the fuel, increased safety in fuel storage, and less offensiveness in the exhaust, alcohol engines will, in part, displace gasoline engines for automobile work, but only when cost of fuel for operation is a subordinate consideration. In this field it is impossible to conveniently increase the compression because of starting difficulties, so that the efficiency cannot be improved as conveniently as in other types of engines. In most localities it is unlikely that alcohol power will be cheaper or as cheap as gasoline power for some time to come.

These conclusions point clearly to the very large possibilities in the development of alcohol power, possibilities which are equally great on the industrial and on the economic side.

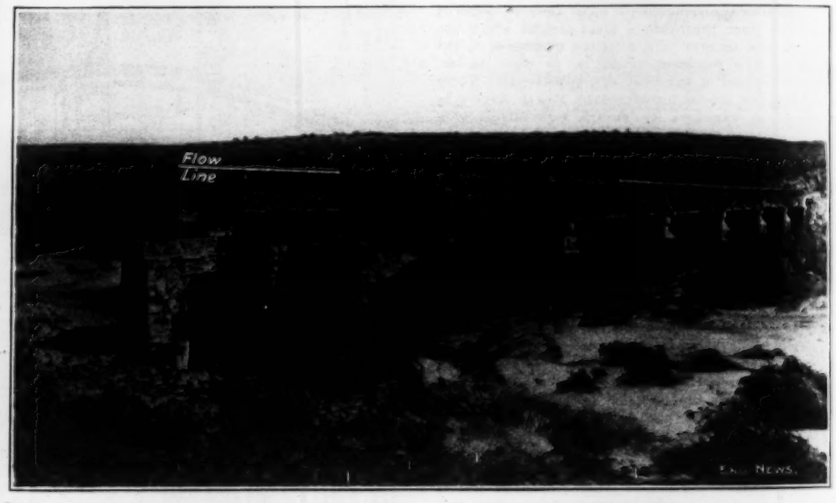
COMPARISON OF FUEL COSTS.

Fuel and type of plant.	Thermal efficiency, per cent.	British thermal units required per horse-power per hour.	Fuel required per horse-power per hour.	Cost of fuel.	Cost of fuel per horse-power per hour, cents.
Anthracite coal:					
Large steam plant	10	25,000	2 lbs.	$2.50 per ton	0.25
Large steam plant	10	25,000	2 lbs.	6.25 per ton	.57
Small steam plant	2½	100,000	7 lbs.	2.50 per ton	1.00
Small steam plant	2½	100,000	7 lbs.	6.25 per ton	2.20
Producer gas plant	18	14,000	1¼ lbs.	2.50 per ton	.14
Producer gas plant	18	14,000	1¼ lbs.	6.25 per ton	.31
Producer gas plant	10	25,000	2 lbs.	2.50 per ton	.25
Producer gas plant	10	25,000	2 lbs.	6.25 per ton	.57
Illuminating gas	20	12,000	24 cu. ft.	1.00 per 1,000 cu. ft.	2.20
Crude oil	10	25,000	1.4 pts.	.04 per gallon	.68
Gasoline	19	13,400	1.1 pts.	.15 per gallon	1.70
Gasoline	19	13,400	1.1 pts.	.30 per gallon	3.40
Alcohol	19*	.....	.....	.30 per gallon	5.00
Alcohol	19*	.....	.....	.40 per gallon	6.70

*Efficiency of alcohol is assumed to be the same as that of gasoline for identical conditions of use.

A STAUNCH SOUTH AFRICAN BRIDGE.

The accompanying half-tone is from a photograph forwarded by Mr. Robert Bromley, Assoc. M. I. C. E., Divisional Engineer, Worcester, Cape Colony, and shows the result of a heavy flood upon the Grier Bridge across the Breede River in Swellendam, Cape Colony. It is a remarkable instance of the resisting power of a riveted, roller-bearing truss.



THE RESULT OF A FLOOD IN A CAPE COLONY RIVER; PUZZLE: FIND THE RIVER.

The bridge consists of six 100-ft. spans through lattice girders set 18 ft. apart on masonry piers founded on rock. The bed of the river, some 25 ft. below the lower chord of the truss, is normally dry, as shown in the view, but the river is subject to very high floods. On August 6, 1906, rain fell in the vicinity of the bridge to the amount of 16 ins. in 24 hours, causing a flood in the stream which finally raised the water to the height of the upper chords of the trusses. This flood came down in a torrent with an estimated flow of 15 miles per hour, bringing with it a great mass of debris, which lodged against the girders and formed a virtual dam, over which the waters flowed. The pressure was so great that the upper rail of the hand-railing, a strong wrought-iron piping, 1¾-ins. in outside diameter, was bowed more than an inch between supports 5 ft. apart. The dirt fill back of the U-abutments was washed out, but this was the sole damage resulting from the flood.

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The Kansas-Colorado irrigation litigation over the respective rights of the two states to the waters of the Arkansas River has at last been decided by the Supreme Court of the United States after years of delay. Engineers and all interested in the larger problems of water utilization have looked forward to a decision in this noted suit to settle some of the questions of conflicting state jurisdiction over water rights. The final decision of the court, however, is disappointing, for the suit is simply dismissed and the conclusion reached is that the Supreme Court does not deem it best to interfere in this case but might do so in some other case where the damage done to one state by the citizens of another could be more clearly proved.

As the law stands, therefore, any state controls the water within its own borders, and its control does not extend a foot beyond. The irrigators of Colorado used up water which had heretofore flowed down to be used by farmers in Kansas; and while the Kansas irrigators would have been protected as prior appropriators against later users inside the Kansas boundary, they have no redress against the later settlers, who tapped the stream near its sources in Colorado.

We do not see why this doctrine that the citizens of a state may disregard the rights of citizens of other states may not be applied to water power as well as to irrigation. For example, it is proposed to build a dam across the Connecticut River below Brattleboro, near the southern boundary of New Hampshire and Vermont. This dam if built will eventually be utilized for storage. A large volume will be discharged when the power-house beside it is carrying the peak of the load, and very little will go down stream when the load is light. This variation in flow may conceivably work serious injury to the owners of existing water-powers farther down the Connecticut; yet if the Kansas-Colorado precedent holds, they have no redress.

Again to cite a still stronger case; it is conceivable that still another dam might be built just below the state boundary in Massachusetts which would set back the water, flood the Brattleboro dam and destroy the power plant. Would the Supreme Court also refuse to interfere in such a case?

It appears certain that sooner or later some legal and equitable plan for adjusting conflicting water rights across state boundaries must be devised and put in force and given sanction by the Federal Government. Many millions of dollars of property are at stake and should be given protection. The possible development of many millions more is hindered by the uncertainty and cloud upon titles which the existing situation creates. The whole problem ought to be canvassed by the new Federal Waterways Commission; and it could hardly exert its broad powers in a more useful way.

The use of copper sulphate as a preventive of tastes and odors in public water supplies has met with little favor in New England. Instead of copper sulphate, aeration and filtration have recently been adopted for the removal of such growths, or their effects, at three places in as many different New England states: Springfield, Mass., Bar Harbor, Me., and South Norwalk, Conn. At the two last-named places, when any treatment is required, double filtration is employed, while at Springfield, single filtration, of the intermitent type, is used. The Bar Harbor plant, which was completed last year (a few months after the one at Springfield) and the South Norwalk plant, now under construction, are described elsewhere in this issue.

It should not be understood that these plants are the first to be constructed for the removal of organic growths or their evil consequences. As early as 1892, a slow sand filter was built at Nantucket, Mass., on account of disagreeable tastes and odors which occurred at irregular intervals of years, due to growths of anabaena in the water. (See Eng. News, April 26, 1894.) Within the past few years the city of Reading has built a filter on one of its sources of water supply, to obviate trouble from organic growths. In 1901 (or late in 1900) an aerating device was added to the mechanical filter plant at Winchester, Ky., to remove bad tastes and odors from the water there (see Eng. News, June 6, 1901). A somewhat earlier aerator, differing in detail, for use in connection with the slow sand filters at Superior, Wis. (for the removal of iron), was described in our issue of Feb. 21, 1901. The Bar Harbor and South Norwalk aerators, it would appear from the descriptions elsewhere in this issue, have a family resemblance to those at Superior and Winchester.

Some of the installations noted above antedate the introduction of copper sulphate as a means of preventing trouble from organic growths in public water supplies. The earlier plants show that before copper sulphate was brought forward, water-works authorities and the public were not the absolutely helpless victims of sudden invasions of anabaena, uroglena and the like, while later plants indicate that notwithstanding all that has been claimed for and accomplished by copper sulphate, a considerable number of people still prefer to place their reliance in the older methods of treating water.

It will be remembered that in the exhaustive report on the advisability of stripping the site of the Ashokan Reservoir (additional water supply of New York City; see Eng. News, Jan. 3, 1907), scant consideration was given to the possibilities of copper sulphate, and that aeration and filtration were recommended.

We do not wish to be understood as opposing the use of copper sulphate. There are times and places when and where its use may be highly advisable. But the signs of the times are that on the more progressive water-works it will be used in sudden emergencies, or where long intervals are likely to elapse between the need for any preventive or remedial measure, rather than where a fairly regular occurrence of troublesome organic growths is to be expected. Moreover, it should be borne in mind that the day when all surface water supplies will be filtered is rapidly drawing near. On most surface supplies that day can be hastened to the advantage of the health and convenience of all water consumers.

It will be remembered that when copper sulphate as an algaecide was first brought to the attention of engineers, strong hopes were entertained that it might also prove an effective and safe germicide for potable water supplies. We find in the report of the Philippine Commission just issued the record of some experiments upon the effect of copper sulphate on water containing cholera germs. The results are reported as follows:

> As a possible safeguard against the infection of the water supply of Manila, the bureau of science, at the request of the bureau of health, made an elaborate series of investigations as to the value of copper sulphate for killing cholera germs in water. Solutions varying from 1 in 50,000 to 1 in 2,000,000 were prepared and cholera organisms were introduced into them. From solutions varying in strength from 1 in 2,000,000 to 1 in 200,000 living cholera organisms were recovered, and they were also recovered after a period of four hours in a solution of 1 in 150,000. As the drinking of copper sulphate at a strength of 1 in 150,000 for any prolonged period could hardly be recommended, prediction as to the value of this substance as a germicide for city water supplies was not verified in this instance.

We think it fair to add the comment that a 1 to 150,000 solution of copper sulphate would probably be less injurious to health than water infected with cholera germs. If a person drinks as much as two quarts of water per day—or four pounds—he would only take about a grain of copper sulphate into his system in a week. As earlier experiments with copper sulphate showed a notable germicide action, it is to be regretted that the Manila experiments were not carried farther. While permanent reliance on such treatment for a water supply would not be expected, it might be of great advantage for emergency use in the treatment of a water supply found to be contaminated.

We recently commented on the occurrence of a number of fires in which buildings of great value but non-fireproof were destroyed with their costly contents. Such fires often reveal that complete reliance had been placed on the protection afforded by municipal fire-department service, and no attempt made to provide local facilities for "first aid." If water under pressure is supplied to the structure, one or more fire-plugs and hose-coils on each floor can do excellent service in an emergency. In the absence of a water-supply, portable fire-extinguishers are a useful resource. In either case there should be some organization, some arrangement of duties, which will ensure that these protective devices are called into use promptly upon the outbreak of fire. There are very few instances where it is impracticable to provide these means of auxiliary protection. There are still fewer, if any, where such protection would not prove its value in the case of a fire.

Incidental to this subject, some tests on so-called fire-extinguishers of the dry-powder class, abstracted in this issue, should prove interesting. They show that such extinguishers [which are tightly-closed metal cans or tubes filled with bicarbonate of soda with which is mixed a small amount of a neutral substance like sand to counteract the tendency toward caking] are able to check an outburst of flame, but generally are unable to completely extinguish it.

In general, the results of the tests indicate that in all ordinary locations water pails, hand hose and similar appliances are far superior for fighting fire to any of the dry-powder extinguishers.

There are, however, certain places where water is used only with difficulty for fire extinguishing. Wherever the temperature goes below freezing, it is necessary to use chemicals in any equipment of fire pails, and even then freezing may occur in severe weather. Again, there are places such as libraries and stores where the damage done by a few pails of water in extinguishing an incipient fire may be very great, and any dry extinguisher, even if it only checked the spread of flame and left the embers to be quenched by water, might save a great deal of damage. Still again, for the extinguishing of fires of inflammable oils, or fires in electric apparatus, the application of water may do harm rather than good. For extinguishing fires in such places, sand is already in general use; but the tests of these commercial dry-powder extinguishers indicate that it might be a benefit to mix a certain amount of bicar-

bonate of soda with the sand and obtain the benefit of the carbonic acid gas evolved when the soda is heated. The bicarbonate of soda, if purchased in bulk, costs only a small fraction of the price charged for the tin tubes of it sold under trade names for extinguishing purposes.

The steam shovel runners at Panama have struck for wages of $300 per month. As was shown by Secretary Taft in our issue of May 9, these men are now receiving $210 per month. They are entitled to 15 days sick leave with pay for each six months' service, and if injured while at work, they have 30 days' sick leave additional. Free medical and hospital service is provided. They have free quarters or free house rent if married and are given six weeks vacation a year with full pay. Additional pay for steady service is granted amounting to 3% per annum. They work eight hours a day.

So long as labor unions operate only to protect their members against employers who will take advantage of a man's necessities to cut down wages, no fair-minded man can object to them; but when—as is nowadays too frequently the case—they attempt to take advantage of the employer's necessities to compel wages far above the market rate that free competition would fix, they bring the whole labor union proposition under deserved condemnation.

The seventy odd steam shovel engineers at Panama have conspired together to quit work in a body in order to compel the Government—that is the taxpayers of the United States—to pay them a salary of $3,600 a year. As a result of their action, they have practically stopped work on the canal excavation. We believe the public will emphatically support the Administration in resisting this demand.

Only a few days ago there came to our attention an article in a British engineering journal, written by an English engineer, who had just visited the canal works. He expressed astonishment at the enormous wages paid to skilled workmen and remarked that in contrast the salaries paid to the members of the engineering profession there seemed very small.

If the steam shovel engineers at Panama think they can do better elsewhere, they are at perfect liberty to throw up their jobs and go. There is little doubt that there will be plenty of competent men ready to take their place at a steady job paying over $2,500 a year with the other attractive features enumerated above.

THE PROBLEM OF FREIGHT CAR SUPPLY AND DISTRIBUTION.

One of the ever present difficulties and causes of friction in railway service is the irregularity and inefficiency of freight car distribution at times of heavy traffic, and this trouble reached an acute stage during the recent period of unprecedentedly heavy traffic. The consequent widespread agitation and complaint not only compelled the railways to a more thorough consideration of the troubles and the means of remedying them, but also induced the government (through the agency of the Interstate Commerce Commission, acting under direct instructions from the President) to make an investigation with a view to determining the cause of the troubles.

It seems to be supposed by some that the recent trouble is an entirely new development, but as a matter of fact it has existed for many years, and has been the cause of active discussion and earnest consideration by railway traffic officers and associations. For the recent failures to handle traffic with reasonable dispatch and to supply shippers with sufficient cars for their needs a number of reasons have been given, each of which is emphasized by those who consider it as the prime cause of the trouble. As a matter of fact, all of these in a variety of combinations with other minor matters have a share in influencing traffic conditions. Some of these reasons, which are factors in the problem of freight transportation, may be noted as follows: 1. Insufficient numbers of cars and (to a less extent) of locomotives. 2. Insufficient track, yard and terminal facilities. 3. Slackness and nonuniformity in the enforcement of per diem and demurrage regulations. 4. Delays of cars in yards in order to obtain heavy trains for the full tonnage rating of modern powerful locomotives. 5. Defective and inadequate tracks, yards and other facilities at industrial plants. 6. The tendency of shippers to hold cars unduly and to use them for storage and warehouse purposes, instead of promptly unloading and releasing them. 7. The system of reconsignment, by which a car sent to a certain point may then be reforwarded to some other point (perhaps back over the original route), with consequent excessive mileage and delay. 8. The lack of systematic distribution of cars, and the inability of railways to keep their cars available for their own use. Some of these matters were discussed editorially in our issue of April 4.

In the early days of railways each road kept its equipment on its own lines, and transfers were required for all freight at connecting points. This gradually gave place to the system of running cars over connecting roads to points of destination, the owner or home road receiving a mileage charge from the connecting or foreign road. For several years the practice was to return the empty car directly to the home road, but this caused an excessive amount of mileage, and about 1875 the practice of using the empty cars for return loads was introduced. The development of the car interchange and car service systems in this country is clearly and concisely reviewed in a paper by Mr. W. F. Allen, Secretary of the American Railway Association, which we print elsewhere.

The interchange system has now developed to such an extent beyond its original and reasonable purpose that to all intents and purposes the entire freight car equipment is common to the use of all roads. When a car has once passed off its home (or owning) road, it may be months before it is returned to that road, and then perhaps only by accident. When unloaded at its destination it should properly be returned (empty or with a new load) to or in the direction of the home road; but as a matter of fact it then becomes available as the property of the road on which it stands, and is used as such. Thus it is hauled from point to point and from road to road, regardless of ownership. Nominally, the owning road is entitled to payment for the time the car spends on foreign roads, but this is mainly a theory rather than a condition, and the charge is not sufficiently high to attain its object in the prompt return of the car or to repay the owner for being deprived of its use. It is cheaper to pay the charge and have the use of the car than to return it and have no cars to supply the demands of shippers. Railway officials frankly admit that when they have heavy traffic to handle, little attention is paid to the ownership of cars, but any that are available are used without hesitation.

It might appear that under this system things are equalized, each road having the use of any and all cars within its reach. But not every road keeps up a sufficient amount of equipment for its needs, and these roads absorb cars purchased by other roads to meet their own requirements. Then, again, cars are of different kinds, and a road owning a number of gondolas for its special traffic may find that it has available mainly box cars from foreign roads; or when it needs its steel-frame gondolas for heavy loads it may find that it has available only old wooden gondolas of light capacity. It is manifestly unjust that a road which has made large expenditures for high-class equipment should find itself actually short of cars or have to conduct its business in inferior cars received from other roads.

When a railway buys new cars to increase the facilities for handling its business it rarely derives the proper return from its investment, the cars being gradually absorbed and appropriated by other roads over which they pass. It has even happened that new cars shipped from contract shops to the purchasing road have been absorbed and put in service before reaching that road. In recent cases it has been stated that railways purchasing new cars have had them shipped as freight (at a cost of some $5 per car), in order to be sure of getting possession of them. The effect of this system is to establish a crude system of pooling, all cars being available to any road. New cars accrue to the benefit of the railways in general and only incidentally to that of the owning road, and roads with insufficient equipment of their own find it easy to maintain an ample number of cars. The system is so crude as to be thoroughly inefficient as regards the economic use of freight equipment, and unsatisfactory to all concerned (except perhaps the road with a small number of cars). In some cases individual cars that have been traced have been off their home roads for two years and more. These are, of course, exceptional, but serve to illustrate the point that a railway does not have the use of its own cars, and that its available equipment cannot be reckoned by the number of cars which it owns.

To such an extent have the troubles grown due to this appropriation of cars that in certain instances railways have temporarily refused to allow their cars to pass off their lines, requiring freight to be transferred at connections with foreign roads, as in the early days of railways. In December, 1906, this action was taken by the Illinois Central Ry., at which time 20,000 of its cars were in use on foreign lines, while it had only 10,000 foreign cars to supply the deficiency. In the same month the entire Pennsylvania R. R. System (including all lines east and west of Pittsburg) had 72,000 cars (nearly 33% of its total freight car equipment) on foreign roads, while it had only 56,350 foreign cars on its lines. The following table is a comparison of the conditions of the equipment of the Pennsylvania R. R. System in April, 1906, and April, 1907; it shows that while 18,354 cars were purchased during the twelve months, there were actually 287 cars less on the road at the end of that period:

	April, 1906.	April, 1907.	Increase or decrease.
Total cars owned	205,389	223,743	+18,354
P. R.R. cars on foreign roads	63,810	80,302	+16,492
P. R.R. cars on P. R.R. lines	141,579	143,441	+ 1,862
Foreign cars on P. R.R. lines	56,663	54,514	— 2,149
Total cars on P. R.R. lines	198,242	197,955	— 287

That the rules and regulations governing the use of cars in interchange service are not properly carried out by railway officials, but are neglected or even purposely evaded in numerous ways, has been amply shown by the evidence of the officials themselves. As to the interchange of cars at connecting points, we noted in our issue of April 25 a paper by Mr. Beecham, Car Accountant of the Chicago, Milwaukee & St. Paul Ry., which showed that empty care are often handled back and forth between the delivering and receiving roads because the respective inspectors disagree as to the condition of the cars. This results in delay and transfer charges, and deprives the owning road of the use of its cars. Disputes of this kind are provided for by the interchange rules, but the rules are not observed. As to the inequitable distribution of cars, we quote the following from a report made in November last by Mr. J. W. Midgley, the expert in car service matters:

> The records show that several companies are accustomed to deliver, under load, 400 or 500 more cars daily than they receive in exchange from other companies. At this rate, roads find at the end of a month that they have delivered 10,000 to 12,000 more freight cars to connecting lines than have been received from the same. The operation of the per diem code has contributed to a situation that is fast becoming unbearable. Borrowers feel justified in retaining cars indefinitely, so long as they pay the specified rental, whereas costly additions to equipment are not acquired by the stronger systems with the view of loaning them or meeting the requirements of companies that are insufficiently equipped.
>
> It is humiliating to have to admit that the disregard of the car service rules of the American Railway Association, which provide for the loading of foreign cars in the direction of home, is greater since the adoption of the per diem code than was at any time experienced under the mileage basis. This truth is not uttered in disparagement of that reform, but with the view of inciting those who are being unjustly deprived of the use of their expensively acquired equipment when it is by them most needed, to insist upon better condi-

tions and to prescribe the manner in which their demand shall be enforced.

So serious was the situation last autumn that in November the representatives of 41 roads owning about 1,100,000 cars adopted an increased charge (or "per diem") of 50 cts. per car per day, without penalty for delay in returning the car. This action was independent of (but assumed as preliminary to) action by the American Railway Association in adopting the increased rate for the purpose of making railways desirous of returning foreign cars. This action has since been taken by the Association, and the increased rate will go into general use on July 1. More stringent rules have also been adopted requiring cars to be returned to the home road direct (except under specified conditions) instead of being "diverted" by being loaded for destinations not on or in the direction of the home road.

The delays of shippers in unloading cars are among the leading causes of car shortage. For this the railways are to a large extent responsible through the very general neglect to enforce the rules purposely prepared to reduce these delays. This is partly for fear of offending the shippers, especially as any one road taking such action would become unpopular, and at a disadvantage as compared with more accommodating roads. There has also been a wide practice of favoring important shippers by allowing them to hold loaded cars (practically as storage warehouses) free of charge for an unreasonable time. An allowance of 48 hours is considered ample, but a few eastern States have laws requiring five days' allowance (which apparently do not apply to cars in interstate commerce). At seaports, 60 days' free storage of freight are allowed in order that vessels may not be held awaiting the arrival of cargo, and it is not unusual for cars to be held for weeks while waiting for ships. Manifestly, cars should not be held in this way. But shippers very generally find it cheaper to use cars as storage, and pay demurrage charges for the detention, than to pay warehouse charges or provide sufficient storage facilities of their own. They also strongly oppose attempts at the more stringent enforcement of regulations or charges designed to secure the release of cars for their proper service of transportation. What would shippers think of a railway which would keep teams at freight houses for days or weeks because it was cheaper to hold the freight in the wagons than to provide sufficient storage capacity.

On the other hand, a movement has been started by some shippers to establish by law what is termed "reciprocal demurrage." The idea of this is that as the shippers are penalized for not returning cars promptly, the railways should be penalized for not furnishing cars when demanded. But shippers not unfrequently order many more cars than they need (to be sure of getting enough), or effect the same purpose by ordering cars from all the roads which serve them. In this way the railway is apt to be deprived of the use of cars ordered and not used, besides incurring additional and costly empty mileage. Thus reciprocal demurrage would logically have to be offset by another charge by the railways for cars supplied, but not used by the shipper.

The original demurrage charge is a legitimate one, to check the unreasonable detention of cars. Reciprocal demurrage is only an attempt at retaliation by those who fail to realize the purpose of the demurrage charge. It could only be followed by further retaliation, with antagonism between the railways and the shippers. Such a state of affairs would be most deplorable, and a much better solution of the problem lies in a policy of eliminating this antagonism (which has attained serious proportions) and replacing it by harmonious relations, in the interests of both parties. There seems to be little liability of legislation being enacted in favor of the so-called "reciprocal demurrage" system. In fact, it was apparently suggested as an attack upon the railways, rather than as a means of relief, and then taken up as a political measure. The Chicago Commercial Association has opposed the Madden bill, which proposed to penalize railways at the rate of $1 per car per day for not furnishing cars when ordered, and also to penalize them for not moving freight cars at least 60 miles in 24 hours. An official of the association stated the matter as follows:

> Shippers do not want money from the railways. They want good service and are entitled to it. Where the railways delay delivering freight within a reasonable time, and the shipper suffers damage, they should be made legally responsible for such damages.

The car shortage became so serious last winter that an investigation was made by the Interstate Commerce Commission into the lack of coal in western towns and the failure of the railways to supply coal during a period of severely cold weather. The railways claimed that dealers did not order coal until so late that it was impossible to fill all orders promptly, that dealers did not provide themselves with sufficient supply or sufficient storage facilities, and that the severe cold interfered with the handling of trains. It was also claimed that coal, shipped through the points whence complaint was made (and at some of which coal was taken by force) was for company use or to supply earlier orders. The investigation showed that the railways and dealers might easily reduce the trouble by so arranging rates and prices as to encourage coal business during the summer and early autumn, instead of concentrating it at the busy season (with a rush of grain traffic) and so late in the season that delays might cause inconvenience or even suffering. Previous to this there had been great complaint at the failure of railways to handle the grain crop. The coal trouble, however, while one of the most serious encountered for several years, was only an acute point in the widespread troubles due to an entire inadequacy of the system of car distribution.

One source of particular trouble is the "individual" car, owned by a shipper instead of by a railway. Such cars are not available for return loads, but must be promptly returned to the owner when unloaded, so that they involve an excessive amount of empty mileage (said to be as high as 50%). These are principally refrigerator and coal cars. Some roads are now adding large numbers of refrigerator cars to their equipment, in order to be independent of "private" cars. The Interstate Commerce Commission, after its inquiry into the coal scandals last year, recommended that private cars should not be permitted in the coal trade, but that the railways should own the equipment and so be free to use and distribute it to the best advantage and in the most economical manner. It may be noted that in England the "private" coal car has for years been an intolerable nuisance to the railways, one great trouble being that the owners often put in service cars of inferior construction and do not maintain them in proper condition. In this country, the inspection system for interchange gives the railways better control over the condition of the cars.

Another great cause of car shortage is the tendency to ever increasing train loads. While the railways are complaining at the unreasonable detentions of cars by shippers, they are themselves holding cars unreasonably at terminals and division yards in order to make up trains of the maximum tonnage rating for powerful locomotives. This matter was discussed in the editorial in our issue of April 4. The questions of tonnage rating and economy in cost of transportation have been given undue prominence, and in fact it has appeared as though low cost of transportation was the main aim of railway operation, instead of being simply one factor in the problem. While it is an important advantage to keep this cost low by concentrating the freight traffic into a limited number of heavy trains representing approximately the full capacity of the locomotives, this practice has evidently been carried to an extreme. Such cases may involve poor facilities for the shippers and the public, the loaded cars being held to obtain full train loads, and being then hauled at slow speed with many incidental delays. The low cost of transportation may then be offset by the long time required for transportation, a car making one trip slowly when it might make two quickly. In addition to this there is the unsatisfactory service due to slow movement of freight and the car shortage resulting therefrom.

The very opposite conditions prevail in England, as far as general freight is concerned. In traveling upon English railways, the frequent succession of freight trains is very noticeable. Many of the cars contain small loads, which represent prompt shipments to fill orders. Many of the trains run almost as fast as the passenger trains, and in fact the freight service has been compared to the express service of American railways. There is, however, a tendency to adopt heavier engines and trains for coal and similar traffic. The freight transfer system has also been introduced at important junction points, so that loads may be concentrated and half empty cars thus released. This gives a greater proportion of live load per car and per train, and also obtains a greater service from the car equipment. When this was suggested some years ago, it was regarded as a feature of American practice quite impossible under English conditions of railway operation. On the other hand, it has been suggested that a fast-freight system for small shipments may become necessary in the more densely populated sections of this country, following the general lines of English practice.

Since the system of per diem charges for the interchange use of cars has failed to give the railways the use of their own car equipment, or an adequate number of cars for their requirements, other methods have been suggested. Among these is the "car for car" system, by which a road receiving loaded cars from another must deliver to the latter an equal number of empty cars, the car audit to be made at specified periods. This is a somewhat crude idea, hardly practicable for general use, and we believe it has never been put in practice except on a very small scale. It would involve considerable empty mileage in the collection of cars by the one road, and their distribution by the other road to the points where they might be needed.

The system which now seems to be growing rapidly in favor is the car-pooling system, in which the cars would be distributed by a central bureau instead of by each individual road. This might be done through the agency of a railway clearing-house or that of an equipment company. Mr. J. W. Midgley states that the first proposition for pooling freight cars and interchange of cars was made in 1875 by Mr. J. R. Cavanagh, then Car Accountant of the Iowa Central Ry. (and now Superintendent of Car Service of the Cleveland, Cincinnati, Chicago & St. Louis Ry.). In 1876, Mr. L. J. Seargeant, General Manager of the Grand Trunk Ry., suggested an interchange system similar to that of the English railway clearing-house. The matter was taken up actively by the late W. G. Wattson, when Division Superintendent of the West Shore Ry., and in 1891 he put forward the economic advantages of a central agency for the distribution of cars. In the same year Mr. S. H. Church, of the Pennsylvania R. R., recommended a pool for box cars. This last suggestion is now revived by Mr. Midgley, who advocates limiting the clearing-house at first to the equitable exchange of box cars, in order not to undertake too large a project at once. This is noted in a report by Mr. Midgley which is given elsewhere in this issue.

In January, 1907, a "car pool" was voluntarily organized by some leading western roads, in order to demonstrate the practicability of the clearing-house system and also to enable the Car Efficiency Committee of the American Railway Association to base its conclusions upon practiced experience. This organization is known as the American Clearing-House, and has been approved by the American Railway Association. Important systems like the New York Central Lines and the Pennsylvania Lines have car-pools of their own, to regulate the distribution of cars over their respective systems. A combination of such pools to form a larger pool embracing connecting systems has been effected, as noted above, and the further step to a general car-pool seems by no means improbable. It has been objected that the distribution of cars over the en-

tire railway system would be a task too great for any one man or one office, but the difficulty is really no greater than for one individual railway system. No one man controls the operation of a railway; division superintendents operate their divisions independently yet in relation to the railway as a whole, and under the control of general superintendents who are in turn under higher executive officers. The same principle would obtain in the organization of a car-pool or clearing-house, and this appears to be one of the minor problems involved in the establishment of such a system.

The purpose and function of a freight car are to transport freight. The greater loaded mileage it makes and the greater proportion of its time that it spends on the road, the higher will be the returns produced on the investment which it represents. To an equal degree, also, do these conditions apply in reducing the necessity of providing further investment for equipment. The present shortage of cars appears to be due in very slight measure, if at all, to an actual lack of equipment or insufficient number of cars. It is due rather to various reasons which prevent the proper amount of service being obtained from the present equipment. The statistics of the Interstate Commerce Commission show a total equipment of 1,681,410 freight cars in 1902 and 1,891,228 cars in 1905; this is exclusive of private or individual cars. The tendency is to build high-capacity cars, although in general freight service the difficulty is to combine a good average paying load per car with a prompt movement of cars. The following table shows the varying proportion of cars of high and low capacity for the two years mentioned:

Capacity.	No. of Cars 1902.	1905.	Capacity.	No. of Cars 1902.	1905.
15-ton	46,353	27,300	30-ton	634,626	738,704
20-ton	327,342	284,616	40-ton	158,179	294,462
25-ton	246,654	206,950	50-ton	48,834	182,729

A uniform and strict, but equitable, enforcement of the per-diem and demurrage charges against railways and shippers respectively would have a great effect in increasing the supply of cars and the car efficiency. It is doubtful, however, whether this alone would prove a solution of the problem as it stands to-day. The handling of the freight car equipment by a single bureau, either in the form of a railway clearing-house or an equipment company, appears to promise a satisfactory solution, and there is undoubtedly already a strong tendency in this direction.

LETTERS TO THE EDITOR.

A Novel Method of Facilitating Pile Driving.

Sir: Recently while visiting Montgomery Ward & Company's reinforced concrete warehouse in process of construction in Chicago, I noticed that in driving piles a stream of water from an ordinary garden hose was allowed to discharge upon the ground at the foot of the pile being driven. On inquiry I found that the contractor claimed that water thus used caused the pile to drive much easier. The claim astonished me greatly, and to prove the matter the contractor made a test in my presence. A 40-ft. pile required 296 blows of a steam pile-driver to drive it without the use of water; and a 45-ft. pile with water required only 164 blows. Please note that the water was not used in any sense as a water jet, but was simply spilled out against the base of the pile. An examination of the inspector's record seemed to show that the above example was representative of the piles driven on that job. It was stated that tests showed that after a day or two the earth settled around the piles driven with the water so that they had substantially the same resistance as the piles driven without the water. The contractor stated that he had had practically the same effect from water in numerous other situations.

The result seems so striking, so simple, and so effective as to warrant the publication of this note. This use of water is new to the writer, and some inquiry has failed to discover any one else acquainted with these facts.

Respectfully submitted,
Ira O. Baker,

Champaign, Illinois, May 3, 1907.

A Tape Leveling Rod.

Sir: Referring to the tape level rod described by Arthur W. Tidd in your issue of April 25, 1907, some twenty years or more ago I proposed to make a tape-rod and made the tape (which I have still) out of webbing. I painted it with feet and tenths running up from a zero point in red and running down from the same point in black. It was intended to be used in railway cross-sectioning in the following manner:

The figures of the cut or fill being known from the center peg of any required cross-section (or from another point near by if more than one set up may be required), the level is set up in any convenient position and the rod held on the peg. The tape is then set to read the given height on the black or descending scale if in cutting or on the red or ascending scale for fill, and the rod being moved to any other point on the cross-section the reading gives the cut or fill at that point.

In connection with such a rod a tape was marked on one side with graduations starting from a point at a distance from the ring end, corresponding to the half width of the roadbed, and having the unit divisions equal to one and a half feet each (for use in earthwork), and on the other side was the ordinary foot scale. So that in use the instrumentman would only have to call out the reading of cut or fill and the rodman would move in or out for the slope stake till the instrument and the tape read alike. Then turning over the tape the rodman would call out the reading in feet for record as the distance right or left of the center line. On moderately even ground (prairie land, for instance) a transit with the line of collimation set parallel with the grade and the rod, or rods, once set could be used for cross-sectioning a number of stations at one set up, so long as it was not used for side readings too close to the instrument.

Truly yours,
J. S. Armstrong, M. Can. Soc. C. E.

Netherwood, Rothesay, N. B., Canada, April 30, 1907.

The Poulson System for the Brooklyn Bridge Terminal.

Sir: In your issue of May 9, 1907, you have an article headed "An Experimental Test of a Railway Terminal System."

It is true, as you say in that article, that for the last five years I have had a plan for bridge relief before the city authorities and that it has received scant courtesy from the Bridge Department, but that, on the other hand, the press, the civic associations and influential citizens have endorsed the plan and urged its adoption. In addition to this, the Brooklyn Chapter of the American Institute of Architects, some three years ago, held a special meeting at which the plan was investigated, unanimously approved of and recommended to the city authorities for adoption. A number of engineers have examined and endorsed the plan, and, on Jan. 2, 1907, the Bridge Department, in spite of its previous opposition, sent this identical plan to the Board of Estimate, saying that it

had been prepared by Mr. C. M. Ingersoll, Chief Engineer of the Department of Bridges, and a Commission, consisting of Professor Wm. H. Burr, Wm. Barclay Parsons and Ira A. McCormick.

The plan was further recommended to the Board of Estimate by its Chief Engineer, Mr. Nelson P. Lewis, who, in a letter dated Jan. 9, 1907, addressed to Mayor McClellan, said:

The plan proposed is certainly an ingenious one, has been carefully thought out, and will fit in with almost any development which is likely to follow the completion of other bridges.

The plan was adopted by the Board of Estimate and an appropriation of $3,250,000 was granted for its installation.

In an editorial in your issue of Jan. 31, 1907, y[ou] say:

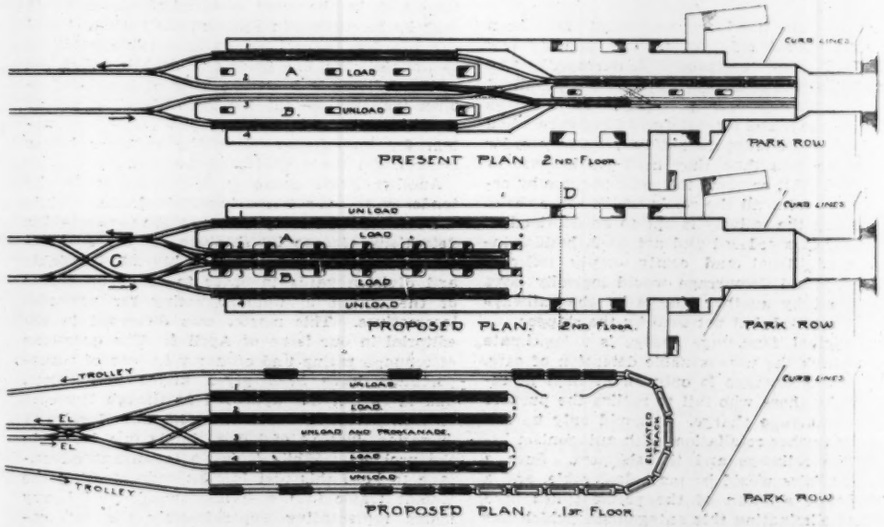
Looking now to the future, it is a pleasure to [be] able to say that the Brooklyn Bridge terminal proble[m] is at last to be solved in a manner which will, we beli[eve] remove it permanently from the field of public dis[cus]sion. We print in this issue the plans adopted for [the] improvement. They have the merit of providing a g[reat] increase of ground space, and of handling the tra[ffic] in-

According to the Bridge Commissioner's layout, [the] will cost about $3,250,000 and take about three years' [time] to install the plan, and the present intolerable [con]ditions will not, therefore, be remedied for years to [come]. I propose to alter the present terminal so as to g[ive] substantial and permanent relief in a few weeks at a [cost] of about $20,000, and the only objection raised by the [Bri]dge Commissioner was that he believed the required [num]ber of trains could not be handled, which opinion was [disp]roved on a test held at Coney Island about a year and a half ago where only 49 trains per hour were operated, whereas at the bridge they now operate 60 trains per hour. I, on the other hand, claimed that with the plan proposed the bridge could be used to its full capacity, which is probably some 75 to 80 trains per hour, and, to demonstrate who was correct, the Board of Estimate ordered a test of the plan to be held at the Culver Terminal at Coney Island, where the conditions could be made similar to what I proposed for the Brooklyn Bridge. But, on April 15, 1907, Mr. Lewis, the Chief Engineer of the Board of Estimate and Apportionment wrote to me as follows:

There is not sufficient room for this new connection which you suggest to allow trains to pass over the proposed new track into the westerly pocket at the same time that a train is leaving the west middle pocket and if this cannot be accomplished the addition would be useless. We will have an opportunity to observe the advantage of such an outside connection by the relative facility of train movement for the two most easterly pockets where this outside connection does occur with that of the two most westerly pockets where it does not occur, and will make an allowance for this difference.

I accepted this condition which Mr. Lewis proposed and it was then decided to hold a trial of the plan on Sunday, April 21, but before the trial of my plan had commenced the power gave out and it was postponed to the following Sunday, April 28. On that day the trains were run as proposed, the trial lasting half an hour, during which time 28 six-car trains were run in and out of the pockets, and I had an opportunity to observe the advantage of the outside connection referred to above—in other words, the layout of two of the pockets was as proposed by me while that of the other two pockets was not—and from the observations of Mr. R. W. Creuzbaur, the engineer of Borough President Coler's office, my engineers and the engineers of the Department of Bridges, all of which agreed within a very few seconds, it was shown that from the two pockets with the correct track layout the trains were operated at the rate of 80 trains per hour, whereas from the two pockets with the incorrect layout they were operated at the rate of 40 trains per hour, so the test proved that the Bridge Department was wrong and I was right.

Another reason why I opposed the lengthening of the terminal into the park, is that the longer this terminal is made the worse the conditions grow; if it is lengthened to receive six-car trains instead of five-car trains, each train being 50 ft. longer will have to move that distance further into the terminal for its first stop and an additional 50-ft. further for its second stop, and the same distance out, which means that each train will have to move 200-ft. further than it does now, which will take from 15 [to]



PRESENT TRACK ARRANGEMENT AT THE MANHATTAN TERMINAL OF THE BROOKLYN BRIDGE, AND ARRANGEMENT PROPOSED BY N. POULSON.

to 15 seconds. That time is lost and has to be recovered, either by conducting 13 to 15 seconds from the loading time, which is impossible; or by running 10 to 12 trains less per hour, which is also impossible if the traveling public is to be accommodated. True, the trains will have six cars instead of five, but five of the present bridge cars (which are now used during the rush hours) accommodate as many passengers as six of the B. R. T. Co.'s cars. It will be seen that matters will be worse than they are now, which certainly should be avoided.

You will find herewith enclosed a sketch showing the present and the proposed plan. With the present plan, during the rush hours the whole traffic is handled from platform "A," which contains only about 5,000 sq. ft., and to enlarge the terminal for the proposed plan all that need be done is to put in two cross-overs at "C," move the stairs as shown and cover up the tracks at the Park Row end of the building. The stairs are placed so that the passengers coming from Brooklyn can step from the train to an enclosed platform with stairs leading down to the present gallery underneath; the outgoing passengers will enter the trains through the center door, and as soon as the incoming passengers are out the gates can be opened so that the passengers can enter the train from the large platform. It will be seen from this that the incoming and the outgoing passengers are entirely separate. The upper floor is practically a huge platform with three slots for trains, and, as there will always be three trains waiting about three minutes in the terminal for outgoing passengers, there will not be any crowding on the platforms or in entering the trains as there will be ample time; the trains can be run in and out of the terminal as fast as practicable without danger of head-on collision as the trains never meet, and a great many over 100 trains per hour can be run in safety provided the bridge can accommodate them.

Please examine the plan and imagine that trains Nos. 1, 2 and 3 are in their pockets and that train No. 4 is coming in; as No. 4 comes in, No. 3 can leave simultaneously on its own track without any danger of meeting the incoming train, and as No. 3 goes in, No. 2 goes out, as No. 2 goes in No. 1 goes out, and as No. 1 goes in No. 4 goes out. This is an exchange of four trains; and the incoming train will never meet the outgoing one except when the two tracks are used to their full capacity (which would be at the rate of 180 trains per hour), then there would be a chance of the first car of the outgoing train No. 4 meeting the last car of the incoming train No. 1 at the cross-over "C," but as no more than about 80 trains per hour will be operated, there is no danger even at that point.

To handle the passengers for the different lines, all that need be done is for the trains, as they come from Brooklyn, to enter any pocket that is vacant, and at the end of the pocket, over the trains, will be a bulletin board with large letters showing the destination of the trains and where the next incoming train will stop, and, in the center between the four tracks, will be a large dial with an arrow pointing to the next outgoing train and on the dial will be a hand which will make one revolution for each train, so that a passenger arriving at the big end platform sees at a glance which train will leave first and when, whether his train is in and where it is, or, if it is not in, where it will be, and he can then decide which train he wants. This can be done without any inconvenience to the traveling public.

That is all there is to the whole problem, and after this is installed a like plan can be put on the ground floor which will then be a terminal and the upper floor can be a union station, divided between the B. R. T. Co. and the Interborough Co., where the trains will meet at the same platform and exchange passengers, and, if the companies can come to a traffic agreement there is nothing to prevent through service between the two boroughs.

It will be noted that the terminal need be only half the length of the present structure so there is plenty of room to spare at the Park Row end of the building; that part can be torn down, and in its place a handsome entrance to the bridge can be erected. You will note that my plan differs from all others in this respect. The authors of those plans think that the present conditions are caused by lack of room and therefore they want to acquire more property and build a larger terminal; this is a mistake, as there is plenty of room and room to spare on the site of the present terminal, provided the terminal is planned correctly and no space and time are wasted.

Yours truly, N. Poulson.

118 North 11th St., Brooklyn, N. Y.
May 10, 1907.

[Since we have gone on record as approving the proposition for increasing the floor space available for handling passengers at the Brooklyn Bridge terminal, Mr. Poulson will pardon us for adding a word of comment. Any passenger terminal designed for safely handling rush-hour traffic in a great city, should be designed with some thought for the accidents and delays that will occur as well as for the normal variations in the rate of flow of traffic. Trains cannot be operated with the absolute regularity of a pendulum's beats. Occasional errors and blockades will occur. The crowds that swarm out of and into the Bridge terminal do not flow uniformly either; and the terminal station and platform must provide reservoir capacity to meet these variations. That is a valid reason, it seems to us, why the added floor space proposed for the new Brooklyn Bridge terminal is worth what it will cost.

It is fair to add, however, that according to our best information, the general plan of the terminal track arrangement recommended by the Burr-Parsons-McCormick Commission last winter, was substantially the same as that which Mr. Poulson devised five years ago, as stated by him above. If this is the case, we see no reason why due recognition of the fact and due credit to Mr. Poulson, for his ingenuity and perseverance, should not be awarded.—Ed.]

Notes and Queries.

B. S., Pawtucket, R. I., writes:

Is a coating of coal tar pitch or asphalt adapted for waterproofing the interior of a reinforced concrete tank or reservoir of 150,000 gallons capacity against a head of 12 to 15 ft.? Are there any objections to the use of such material when the water is not to be used for drinking purposes? Is the "Sylvester Process" better adapted for use under such conditions?

We believe the Sylvester process will give more satisfactory results under the conditions stated.

A news note in our issue of May 9, taken from newspaper dispatches, stated that between 15 and 20 Mexican laborers were killed and 13 injured by the fall of a wall of the Chuviscar dam, near Chihuahua, Mex. Mr. Thomas Shepperd, of the engineering and contracting firm of McQuatters, Truehart & Co., writes that but one man was killed—Mr. Alexander H. Holmes, the American foreman of the working party—and three Mexicans injured. The workmen were excavating below some sheeting that was in place, in order to place additional sheeting to retain a bank of sand and rock. A workman carelessly removed a strut and the bank of sand caved in and caught several men, with the above-mentioned results.

Referring to the tables of Channel Depths at Various Ports given in our issues of Dec. 27, 1906 (p. 692) and Sept. 6, 1906 (p. 254), it seems that the harbor of Sydney, N. S. W., Australia, was omitted. According to Dr. Bohny, of Sterkrade, Germany, the navigation channel in this harbor has a minimum depth of 34½ ft. and a mean depth of 49 to 50 ft. The port has four graving docks, excavated in rock. Two of these belong to the provincial government and have dimensions of 500 by 59 ft. and 635 by 84 ft., taking vessels with a draft of 21½ ft. and 32 ft., respectively. The other two, belonging to the Morts Dock & Engineering Co. Ltd., have horizontal dimensions of 640 ft. by 69 ft. and 765 ft. by 82½ ft., taking ships of 18 and 28 ft. draft, respectively. There are also five floating drydocks, of smaller size, in the port of Sydney.

THE POLLUTION OF NEW YORK HARBOR.*

By GEORGE C. WHIPPLE,† Assoc. M. Am. Soc. C. E.

The Statue of Liberty stands at the center of a circle of 18 miles radius which bounds the limits of New York City and extends over 45 cities and towns in the state of New Jersey. This circle covers about 1,000 square miles, of which three-quarters is land and one-quarter water.

Within this circle dwells a present population of about 5.5 million people, of which 4.5 millions are in New York and one million in New Jersey. The sewage of this Metropolitan district amounts to at least 500 million gallons a day, perhaps 600 million gallons, while to this must be added large volumes of street wash at times of rain.

Through the district there flows one large river, the Hudson, and several smaller ones, the Passaic, Hackensack, Rahway, and Elizabeth in New Jersey, and the Bronx River in New York. The Harlem River and the East River are tidal channels rather than true rivers. New York Harbor, or speaking more exactly, the "Upper Bay," stands at the center of the circle and from its appearance on the map would appear to act as a receiving basin for these various streams. The Hudson enters it at the north, the New Jersey streams, flowing through Newark Bay and the Kill von Kull, enter it at the west; on the south, at the Narrows, there is a main discharge to the Ocean, and on the east a secondary connection with the Ocean through Long Island Sound.

This picture of a receiving basin, or, as it has been termed, a great cesspool for the sewage of New York City, is not wholly a true one, for a study of the soundings in the Harbor shows that the Hudson River Channel preserves its identity and passes as a deep cut through the Upper Bay, through the Narrows and well into the Lower Bay. The Kill von Kull is a tributary to this submerged river, while that part of the Upper Bay west of the channel is where the old Hudson River overflowed its banks when the region sank. The water over the Jersey Flats is only 5 to 10 ft. deep at low tide and there are places where the depth is less than 2 ft. It is not impossible that another century may see these flats covered with buildings.

The pre-historic Hudson River discharged into the Atlantic through a sort of delta, very much as the Mississippi River does now, and like the Mississippi it deposited its load of silt in the delta. These submerged deposits form the bar of to-day, which really, though not superficially, marks the outer boundaries of the Lower Bay. There are three channels through the bar, the Main Channel, used by ocean-going steamers, the Swash Channel, and the Ambrose Channel now being dredged. Beyond the bar is the open sea.

The Harlem River acts as a cross-connection between the Hudson and the Sound, and the Arthur Kill as a cross-connection back of Staten Island between Newark Bay and the Ocean. Jamaica Bay is a shallow extension of the Lower Bay on the south side of Long Island, between Rockaway Beach and the Brooklyn shore.

These waterways receive directly or indirectly practically all of the sewage of the district, thus far without any attempt at purification. For the most part sewers of short length discharge the sewage at the nearest point at the shore, though in Brooklyn and the Bronx there are several trunk sewers which convey the sewage of large districts to distant points. In all there are upwards of 350 sewer outlets which discharge into the waters which wash the shores of the district, exclusive of those which discharge into the New Jersey streams. Practically all of the sewage of five million people, therefore, passes into the harbor of New York, except that which settles in Newark Bay or the other streams and tidal channels.

The New York Metropolitan district is adding from 30 to 35% to its population every ten years. If this rate is kept up, in another generation the population within 18 miles of the Statue of Liberty will be nearly ten million instead of five and a half, and the amount of sewage entering the Harbor will be a billion gallons a day, enough to cover the Upper Bay to a depth of nearly three inches if it were all concentrated there—which, of course, it will not be.

Looking forward to the conditions which may obtain a generation or two hence and taking into account the intolerable conditions which now exist at certain points along the water-front, such for instance as the Gowanus Canal, and Newtown Creek, in Brooklyn, besides many local nuisances of lesser magnitude; considering also the experience of other cities where the waterfront has become offensive on account of excessive pollution, sanitarians have been for some years looking with concern at the possible dangers which confront New York. This has been stimulated by the projected trunk sewer in the Passaic River Valley which is designed to take the sewage of Paterson, Newark and other New Jersey communities out of the river and deliver it directly into New York Harbor, instead of allowing it to enter through the Kill von Kull as it does at present; also by the Bronx Valley sewer, which is intended to divert the sewage of a portion of Westchester County from its natural drainage into the Bronx River to the Hudson.

As a result of the agitation, the New York Bay Pollution Commission made a preliminary study of the subject in 1904-5, and this study is being continued by the Metropolitan Sewage Commission, now sitting. Individuals have also discussed the subject in the scientific journals and the daily press, sometimes upon insufficient data, and as a result there has been gradually creeping over the community a feeling of alarm, which conservative sanitarians believe to be unwarranted by the conditions.

That local nuisances from the disposal of sewage in the harbor exist to-day cannot be questioned. They ought to be abated at the earliest possible moment. That there is a limit to the amount of sewage which the harbor can receive must also be admitted, and before that limit is reached steps ought to be taken to avoid the general nuisance which must follow. The point at issue is as to when this limit is likely to be reached and where and in what way trouble is first likely to manifest itself. This is the fundamental question which must underlie all discussions of policy and all attempts at remedy.

What is the capacity of the harbor of New York to receive sewage without giving rise to a general nuisance? This question cannot be fairly answered at this time, for the facts upon which the answer depends are not known. We can and we have made many estimates, and as a result some sanitarians have arrived at one conclusion and other sanitarians have arrived at other conclusions.

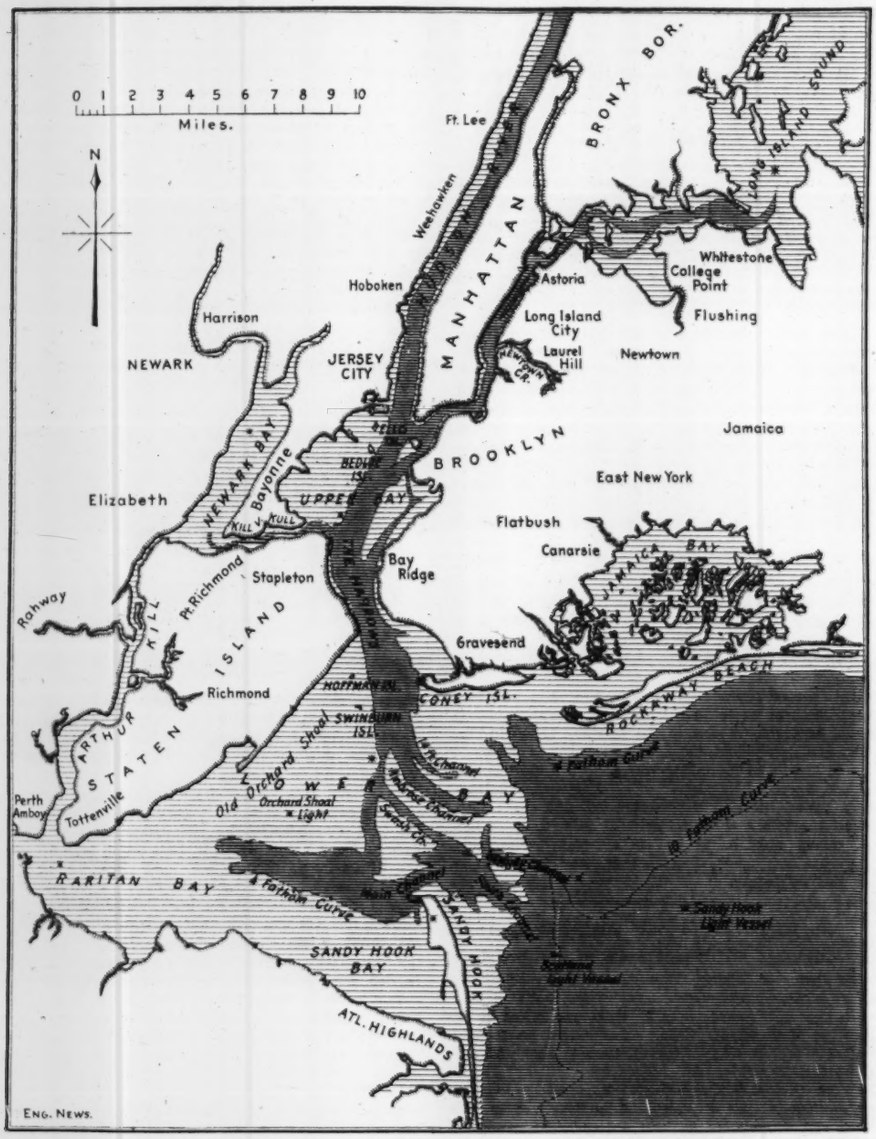
We think we know a good deal about the hydrology

*An address delivered before the New York County Homeopathic Medical Association, May 9, 1907.

†Consulting Engineer, 220 Broadway, New York City.

of New York harbor, but we really know very little. How much sea water comes in at each tide? How much Hudson River water leaves the harbor by way of the East River, or does any of it leave that way? How long does the river water linger in the Upper Bay before going out to sea? How much silt is carried into the harbor by the Hudson River? Where does it settle? How much suspended matter, and how much organic matter does the sewage contain? What becomes of this sediment? What effects have the current on dispersion? What effect has the wind on the tidal flow? What is the extent of the under-run of sea-water? And what is the influence on sewage dispersion and on sedimentation? What are the laws which govern dispersion when a stream of sewage of low specific gravity enters a body of sea-water of higher specific gravity? These and it is not so used at the present time is evident to any one who compares the sluggish flow of the North and East Rivers near the shores, where the sewers discharge; with the great volumes of water which circulate up and down in the main channels with each incoming and outgoing tide.

But to study the various aspects of dilution brings us face to face with another fundamental phase of the city sewerage problem—namely, the location and arrangement of the main sewers. From the natural advantages of Manhattan with respect to the shore line the location of main sewers has been a simple problem, but in the other boroughs there are large areas where the problem is not so simple. These areas are developing with great rapidity, demanding the constant extension of sewers. To a considerable extent this work is going



MAP OF NEW YORK HARBOR AND ADJACENT WATERS, SHOWING LOCATION OF DEEP WATER CHANNELS.

many other questions concerning the fate of the sewage bacteria and the sewage sludge demands an answer based on a study of the subject which shall be commensurate in magnitude with the importance of the interests involved.

The disposal of sewage by dilution is generally recognized by sanitary science as a legitimate, economical and generally satisfactory method, provided the proportion of the sewage to the water into which it is discharged is not too great, provided the mixture of the sewage with the water is prompt and thorough, and provided problems of water supply or shellfish are not involved.

Disposal by dilution is the natural method for a city like New York situated by the sea and provided with the great tidal estuaries which here exist, and whatever may happen in the future it seems absolutely certain that this method of disposal will be used for many years to come. Such being the case, every effort should be made to use this method to its best advantage. That on without the existence of well defined and carefully considered plans, and unless this is rectified in the near future disaster or great expense to the city will inevitably result.

Take for example, the Borough of Queens, now made up of separate communities somewhat widely separated, just as was the Borough of Brooklyn a generation ago. These separate communities have their independent sewer systems. But it will not be many years before these communities will grow together, and there will then be demanded trunk sewers of large size. Such trunk sewers need not all be built at once, but the general plans should be so laid out that the extensions as they are needed can be made to fit them, so that in the future it will not be necessary to design the main trunks to fit the little feeders. These main trunks should also be designed with reference to the best method of disposal by dilution and with due consideration of the need of purification in the future.

There are, then, these three phases to the problem of sewage disposal in New York—named in the order of their immediate importance—first, that of the location of trunk sewers; second, that of proper dilution at the outfalls to prevent local nuisances; and, third, that of the capacity of the harbor to receive the sewage of the future Metropolitan district.

Having now considered some of the things we don't know about the subject, let us turn to some of the things we do know, even though we know them imperfectly and in part.

The amount of sewage matter which enters the harbor can be estimated approximately from the population and from our general knowledge of the constituents of sewage. Making a fairly liberal allowance for manufacturing wastes, and street wash and taking into account both matters in solution and those in suspension, the total quantity is found to amount to upward of 2,000 tons per day, of which about 800 tons is organic matter subject to decomposition. There is probably 1,200 tons, at least, of matter in suspension, 40% of which is organic. The New York Bay Pollution Commission estimated this supended matter as 1,000 tons per day instead of 700 tons, and possibly the larger figure may be nearer the truth.

If the harbor of New York were a body of standing water the sanitary conditions would have become intolerable years ago, but it is very far from being a body of standing water. The drainage area of the Hudson River is 13,268 sq. miles, and the combined catchment area of all the streams entering above the Narrows is given by the Government engineers as 16,335 sq. miles. The average daily flow of these streams is about 10 billion gallons per day, the minimum flow, 2.5 billion gallons and the maximum flow perhaps 150 billion. There must also be considered the tidal flow, which is the real controlling factor and which has been estimated as about 200 billion gallons per day. This alone is enough to dilute the sewage of a population almost equal to that of the whole United States.

The problem is not a simple one in proportion, however, and rules that apply in a continuously flowing stream cannot be used when there is an ebbing and flowing tide which exceeds in volume the flow of the streams itself. Not all of the day's flow of the Hudson River leaves the harbor in a day and not all of the sea water which enters the harbor through the Narrows is new water which has not been in the harbor before. The river reaches the sea by an intermittent flow, like the old toy image of the Ben Butler, which used to take two steps fofward and then one step backward. In the discussion of a paper by Dr. George A. Soper, on "The Pollution of the Tidal Waters of New York City," Mr. Allen Hazen gave the results of calculations, based on the best data available, which showed that about 79% of the water which passed out through the Narrows comes back again on the succeeding tide, and that 21% goes out never to return. He stated that "of the gross amount of water flowing out of the Narrows with each ebb tide 7% is river water on its last trip out, 28% is river water that will come back, 14% is sea water on its last trip out and 51% is sea water that will come back. These figures are merely illustrative, as the data upon which they are based are meager. They do not take into account the great underflow, but they serve to show the importance of the tidal movement in connection with the disposal of the city's sewage.

All of this vast tidal flow is not available for the dilution of the sewage. The sewers discharge at points near the shore, but the great volumes of water pass through the central channels. Every one who has crossed from Manhattan to New Jersey or to Long Island must have noticed how much greater the velocity of the water is in midstream than along the shores. The water in the Hudson River, for example, flows in lines parallel to the shore, and there is little mixing of the water from one side to the other, unless, perchance, through the action of winds blowing across the river or through the swerving of the main channel from side to side. Practically speaking, it is only the water near the shores which is utilized for dilution under present conditions.

The conditions which affect dilution are quite dissimilar along the different shores. The East River receives more sewage in proportion to its width and volume and to its tidal flow than the North River and the analyses indicate a higher degree of pollution. It is not possible to treat the subject of dilution in a general way—it must be studied locally at each point on the shore and in the main channels.

The harbor water is a mixture of fresh water and sea-water, but the proportion is not constant. In the spring when the stream flows are large the water in the upper bay may be more than half fresh water, while during dry periods it may be three-quarters sea water. The proportion is different for the flood and ebb tides, and it is also affected by the winds.

The Hudson River below Albany must be considered as a great tidal estuary. The salt water flow extends up the river anywhere from Yonkers to Poughkeepsie according to the flow of the Hudson, the height of the tide and the direction of the wind. Tidal variations of

the water in the river are noticed even at the foot of the Troy dam, where the differences in elevation between high and low tide amount to about 2.5 feet. It takes from nine to twelve hours for the crest of the tidal wave to flow from the battery to Albany, hence before one high tide reaches Albany another has started up the river.

Salt water is heavier than fresh water. It, therefore, tends to creep up to the bottom, and in an incoming tide it creeps under the outgoing water, which is fresher and lighter, giving rise to the so-called phenomenon of the "under run." In the lower Hudson this is well marked, at higher up, as the river is less brackish, its influence is less felt. During the spring the fresh water spreads out as a comparatively thin layer, while the salt water tends to keep to the bottom of the deep channels.

In considering the present-day condition of the harbor the subject must be viewed from the two very different standpoints, namely, from that of public health and from that of public aesthetics, or from the sanitary standpoint and that of common nuisance. The two are not necessarily related to each other. Sewage may be diluted in water, or attenuated to a degree that would surprise even a homeopathist, and yet be potentially dangerous to a person drinking it; on the other hand, a person might sail in a boat over a sea of sewage, or work in sewers as thousands of laborers do, without ill-effects. These two aspects touch all phases of the subject and materially affect matters of policy and cost. Everyone will admit that when questions of the public health are concerned, no cost is too great to avoid danger; but the elimination of nuisances which are merely unsightly, or unpleasant in other ways, is a different matter and one where we may well apply the maxim of old Polonius, "Costly thy habit as thy purse can buy."

If the harbor pollution is now a menace to health or is likely to be, the matter is one of the highest importance to the welfare of the city, but if it is merely a question of nuisance or a series of nuisances it behooves us to ascertain how these nuisances can be removed so as to give relief to the greatest number of people, in the shortest time and at the least cost to the city.

The New York Bay Pollution Commission has put its finger on the two sources of danger to public health from the pollution of the waters around New York, namely, that of contracting disease by bathing in sewage-contaminated water, and by eating oysters, clams or other shell-fish which have grown or been kept in water infected with disease germs. The bacterial analyses of the waters around New York, as reported by Dr. Soper, show that nowhere above the Narrows is the water free of sewage contamination. The colon bacillus, the common index of fecal pollution, is widely distributed through the waters of the harbor, though, of course, not equally distributed. The water over a large part of the region above the Narrows where oysters and clams are gathered has been shown to be contaminated, and the oysters themselves have been shown to be contaminated.

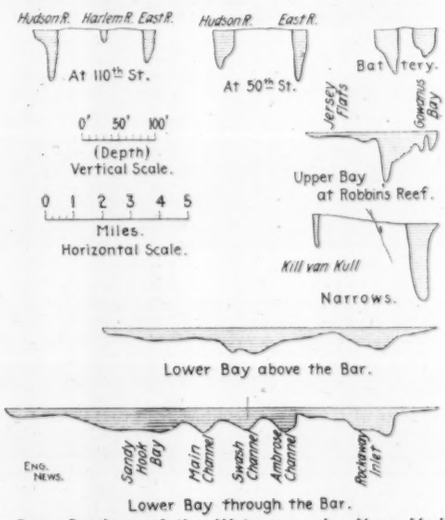
During the summer the waters of the bay are used for bathing by untold thousands. The great beach resorts are below the Narrows. Rockaway Beach is outside the bar and its shores are washed by the open sea. Coney Island and Midland Beach are inside the bar and the chance of contamination at these places is somewhat greater. Public bathhouses are located along the water front at numerous points in the North and East Rivers, and at some of these places the conditions are bound to be unsanitary.

What can be done to render bathing in the East River and the Hudson River less dangerous to health? It is certainly not practical to discontinue the discharge of sewage into these rivers—nor would it be wise to discontinue public bathing establishments. It may be impossible, perhaps, to avoid all dangers of contamination; in fact, even if all outside dangers were removed there would still remain the danger of the bather infecting a bathing tank in which others are swimming. The location of a public bathhouse should be made with the greatest care and with special reference to the avoidance of the great sewer outfalls. The possibility of pumping water into the tanks from the middle of the channels instead of taking it from near the shore where it is polluted, the use of Croton water instead of sea water, and the disinfection of water are ideas worthy of consideration.

The greatest danger to the beaches is from local sewers. As time goes on the waters which surround Coney Island are likely to become more and more contaminated. This region should be studied in detail to ascertain the trend of the local currents. It is quite likely that sewage purification works of a modern type in this vicinity will be one of the sanitary demands of the near future. On Staten Island there are also a number of important problems of beach pollution. Infection at the beaches may occur in various ways, by getting contaminated water into the mouth or eyes, by eating food contaminated by flies which have been in contact with shore deposits of sewage slude. The possibility of fly transmission of disease from shore deposits at other points along the water front is something that ought not to be lost sight of. How important its influence may be on the health of the city is not known.

The oyster industry in the vicinity of New York is vitally involved with the pollution of the harbor. Wherever sewage matter is deposited, even though it be in small quantities, there it is unsafe to cultivate oysters or to fatten them. Oysters and clams from a contaminated region are a menace to health and their sale should be prohibited by the health department. Some of the oyster beds around New York have been irretrievably ruined; others have been seriously endangered. As pollution increases, they also may have to be abandoned. It does not seem likely that the oyster layings which are at any considerable distance outside of the bar will be seriously affected by the pollution of New York for many years to come, as in all probability, most of the sewage matter settles or is destroyed inside the bar. In Jamaica Bay, Gravesend Bay, and around the shores of Staten Island the conditions are sure to become serious, in fact, in many instances, are already so. These layings should be under the supervision of the health authorities and regions found to be open to contamination should be abandoned.

The speaker believes that the sale of local oysters should be severely restricted and conducted only under certification by the proper authorities. It would be wiser to reduce the danger by restricted sale than to indulge in the wholesale contamination of the local oyster industry. It seems likely also that the oyster dealers would find it to their interest to put on the market oysters which have been certified as to their safe origin, just as milk is now certified.



Cross-Sections of the Waterways in New York Harbor at Different Points.

The nuisances resulting from the too great accumulation of sewage at certain points along the shore and in some of the inlets may be classified under the following heads: (1), Miscellaneous litter; (2), Discoloration of the water by suspended matter, dye stuff, etc.; (3), Odors of oil and of decomposition; (4), Oily sleek on the surfaces; (5), Shore deposits of offensive sediment.

Along the shores of the East River, from the Battery to Blackwell's Island, the litter which is seen floating in the water is the most conspicuous nuisance. An observing patron of the Fulton Ferry has kept a list of what he has seen floating during the past year in the ferry slips. This list includes dogs, cats, bottles, neckties, a feather bed, all sorts of garbage, driftwood, straw, and a thousand and one things. What is the origin of this litter and how can it be prevented? Much of it is undoubtedly thrown overboard from boats and from the wharves. A large part of the garbage comes from the sewers. Statistics from other large cities show that every million gallons of sewage contains about 0.25 cubic yard of matter that can be screened out on a half-inch screen. For a city like New York this would amount to about 150 cubic yards per day—almost enough to cover an acre to a depth of two inches. This matter scattered along the shores and collecting in eddies is enough to become very conspicuous. Some garbage is doubtless dropped from the scows which carry it to the disposal works at Barren Island.

Discolorations of the water is most conspicuous when the sewage is discharged into some slip or inlet. The Gowanus canal, with its black, fetid, bubbling liquid is one of the most glaring instances of intensified pollution. Work is now under way to provide an abatement of this nuisance by forcing a circulation of water through the canal at an initial expense of a million dollars, to which must be added heavy maintenance charges—an excellent example of the effects of tardy and perhaps ill-advised action on the part of the city authorities. The prevention of pollution might have been accomplished at far less expense if taken in time. Newtown Creek is another glaring case of intense pollution by manufacturing wastes. It is one of New York's sore spots, upon which it will be necessary to spend large sums of money in the near future. The Harlem River is also in danger of an overdose of sewage if the Bronx continues to grow at its present rate.

There are two well marked groups of odors caused by pollution—first, the characteristic odor of decomposing sewage, and second, that of manufacturing wastes—especially oil wastes. These are all local, but in many places they are very bad. The works of the Standard Oil Co., at Bayonne, the oil works along the Newtown Creek, and particularly the gas works, contribute largely to these odors. Wastes from the gas works produce odors many times more noticeable than sewage, and these are mistaken for sewage by many people.

The oil and gas wastes also impart an offensive appearance to the harbor water near the works by causing an oily sleek on the surface, suggestive of pollution. Sewage from some of the large outfalls does the same.

Another noticeable nuisance in the harbor is the deposit of sewage sludge along the shores. The piles and the wharves become coated with it, vessels become coated with it, and the ice in the winter is conspicuously fouled. It forms deposits, sometimes in large amounts, on the shelving beaches which underlie many of the wharves, and on the debris which accumulates there. This is especially important where the sewers discharge at the bulkhead line instead of at the pierheads.

There is a curious negative side to this nuisance. Wooden piles exposed to tidal action are destroyed in most harbors on account of the action of the Teredo and other living organisms. Not so in New York. The water around the docks is so polluted that they cannot live; consequently the piles are preserved.

These nuisances affect many people—those who patronize the ferries and the excursion boats, ship-owners, those who do business at the docks, those who patronize the water front parks, and those who live along the shores. They are all practical matters, but essentially local, and subject to local remedy. Many of them could be remedied by an extension of the sewer outlets to the pierheads by having them submerged at low water and by providing some more or less elaborate device for getting the sewage quickly and thoroughly mixed with the water of the main currents. In the case of the larger sewers, screening would reduce the amount of litter and lessen the shore deposits of filth, thus being a sanitary benefit as well. It might even be possible to combine some of the smaller outlets, for the purpose of economical screening. These suggestions are by no means new; they were made to the Sewer Department by Mr. Rudolph Hering more than twenty years ago. The substitution of solid docks with vertical walls for the shelving shores covered with piles would do much to prevent the accumulation of filth.

One other effect of the harbor pollution remains to be considered, namely, the problem of silt. It was said above that a mass of suspended matter equal to nearly 1,000 tons is discharged from the sewers each day into the waters around New York. The Hudson River is not always a clear stream; its waters frequently contain more or less silt and clay. In the spring the turbid brownish-yellow color of the North River is conspicuous, especially at ebb tide. From the best available data on the turbidity of the water, it has been calculated that the average amount of clay and silt brought down by the Hudson to be about 10,000 tons a day. The suspended matter of the city's sewage therefore amounts to about 10% of the total sediment which is now accumulating in the harbor.

Where the bulk of this sediment is deposited, no one fully understands. That it tends to settle where the current of the water is retarded and that it does not settle where the currents are swift is naturally to be expected. The two most conspicuous regions where the cross-section of the tidal stream is expanded are first, the Jersey flats, and, second, the lower bay at or behind the bar. In all probability these are the principal regions of deposit. Probably a third at least of the suspended matter does not settle in the harbor at all, but is carried seaward in a finely divided or colloidal condition.

What is likely to be the effect of the continuous deposit of a mixture of 10% sewage sludge with 90% of river silt, more or less, on the condition of the harbor? The speaker cannot see how it is likely to become serious from the sanitary standpoint, or even to give rise to any nuisance other than that of silting the channels and obstructing navigation. There may be spots where the per cent of sewage sludge may be great enough to cause a local nuisance, but that the harbor is going to suffer a general nuisance from this cause he does not believe. The problem is one of the most interesting and important ones involved in the whole subject and ought to be more carefully studied than it ever has been.

The situation with respect to the pollution of New York harbor may be summed up as follows:

The discharge of the city's sewage along the water front has irretrievably ruined the oyster beds in all regions above the Narrows. The sale of oysters from these regions should be prohibited.

The oyster beds below the Narrows have been partially injured. The use of oysters from these regions should be under the restrictions of the health authorities, but not all beds need be condemned at the present time.

The contamination of the harbor has introduced an element of danger in bathing in the waters above the bar. The danger is greater in some locations than in others, and the remedies are correspondingly local. Sewage purification near the beaches will be one of the demands of the near future.

There is no general nuisance in the harbor resulting from the present method of disposing of the city's sewage by dilution, but how long this immunity will continue cannot be foretold from the data at hand. It is not likely to occur within the lifetime of any one now living.

There are numerous local nuisances along the waterfront, such as litter, discoloration of the water, foul odors, and deposits of slime and sludge. These might be materially eliminated by better police regulations as to litter, by a screening of the sewage, by the submergence and extension of some of the sewage outlets into the stream, as far as or beyond the pierheads, and by the improvement of the conditions under the wharves. The larger the sewers the more elaborate should be the precaution to prevent nuisances. Each trunk sewer outlet, especially each proposed new one, should be marked for separate study, with a view to the prevention of trouble around the point of discharge.

There are three principal directions along which investigation ought to be made—first, a study of the sewers themselves with respect to the districts to be drained and the points of disposal; second, a study of the local conditions at each main outfall with a view to utilizing the method of disposal by dilution to better advantage; third, a study of the times and currents of the harbor with the object of ascertaining the fate of the sewage, and of foretelling the effect of future pollution on the quality of the water, and the practical result of the method of disposal by dilution on the health and comfort of the citizens of New York. The whole subject is not one for immediate alarm, nor on the other hand is it one to be carelessly brushed aside.

THE LARGEST STEAMSHIP—PRO TEM.

Until the two new Cunarders, the "Lusitania" and "Mauretania," are put into commission, the steamship "Adriatic," of the White Star Line, which reached New York on May 16 on her maiden voyage, will hold the distinction of being the largest steamship completed and in service. Her displacement is greater than that of the "Baltic," of her own line, or of the "Amerika" and "Kaiserin Auguste Victoria," of the Hamburg-American Line.

The present "Adriatic' is the second of her name which has been built for the White Star Line; both were from the works of Harlan & Wolff, at Belfast, Ireland. The first "Adriatic" was launched in 1872; the second in September, 1906; it is interesting to compare the figures and dimensions of the two boats:

Length over all, 725 ft. 9 ins., and 449 ft. 6 ins., respectively; beam, 75 ft. 6 ins., and 40 ft. 9 ins.; depth, 50 ft. and 30 ft.; gross tonnage, 25,000 and 3,887; passenger accommodations, 3,000 and 869; crew, 489 and 143.

A number of novel features have been embodied in the new vessel, but the most decided innovation is the provision of Turkish baths; these have the usual rooms of varying temperature, and a plunge bath as well. Electric elevators, already introduced in the "Amerika" and "Kaiserin Auguste Victoria," run from the first-class entrance on the boat deck to the first-class dining saloon—which is, by the way, located on the upper deck. A gymnasium is provided, and also three electric baths.

In the matter of speed the new vessel is in the class with the other larger vessels of the White Star Line, in which large freight carrying capacity is combined with fine passenger accommodations. She will probably occupy seven days in making her voyages.

Recent vicissitudes encountered by the "Baltic" and "Cedric" in getting in and out of New York Harbor suggest coming difficulties in handling their heavier sister, until the completion, at least, of the first stage of work on the Ambrose Channel. There is supposed to be at least 30 ft. of water in the present channel at low tide, but in thick weather it is not always easy to locate—particularly when under the necessity of keeping clear of vessels travelling in the opposite direction. The completion of the first stage of work on the Ambrose Channel will give a depth of 35 ft. at low tide; the latest estimates of the engineers in charge of the work are that the channel will be available for navigation during the coming summer.

A BOMB-PROOF PUMPING STATION AT GIBRALTAR.*

By ALBERT WILSON, Assoc. M. Inst. C. E.

For the purpose of rendering bomb-proof and secure in time of war, the pumping machinery upon which the population of Gibraltar is dependent for its supply of brackish water for sanitary and general domestic purposes, a pumping station has been hewn out of the solid rock.

The excavated chamber is 80 ft. in length, 40 ft. in width, and 15 ft. in height, and is subdivided into an engine room, a boiler house, and a coal store. The rock was found to be sufficiently strong to permit of the roof being left flat without other support than that afforded by the walls of the chamber. The machinery includes two 100 HP. triple expansion pumping engines, with surface condensers and three water tube boilers. The coal store is designed to hold 160 tons of coal.

The thickness of the covering of solid rock over the pumping station is sufficient to afford protection to the machinery against injury from bombardment, and arrangements have been made whereby every opening can be blinded in case of war.

The natural draught of the smoke-flue, supplemented by the opening for the coal-supply (through which a large portion of the hot air generated in the pumping station passes), provides ventilation for the whole of the pumping station, the engine-room and coal-store being directly connected to the boiler-house by openings in the division walls.

The pumping station is entered by a heading 127 feet in length, 8 feet in width, and 7 feet in height, sloping into the station at a gradient of 1 in 7½. The smoke from the boiler furnaces is removed by a flue, formed out of a heading 25 feet in length, 5 feet in width and 6 feet in height, and a chimney, formed out of a shaft 5 feet square and 42 feet in depth, sunk through the rock. The coal is admitted by a shoot, tapering in cross-section from 20 feet by 5 feet at the inner end, level with the roof of the excavation, to 7 feet 6 inches by 5 feet at the face of the cliff. The coal is brought to the mouth of the shoot by means of an electrically driven coal-transporter; it is lifted from the road a vertical distance of 47 feet, in a skip carrying 1 ton, and is then run horizontally to the point of discharge, a distance of 97 feet, the complete operation being effected in two minutes. The ashes from the furnaces are removed through a separate passage 89 feet in length, 3 feet in width and 6 feet in height, with a slope of 1 in 6¾, and are delivered into carts through a small hole in the face of the cliff. The pipes, conveying the water to be pumped, comprise an 8-in rising-main from a smaller pumping station on the site of the wells, and an 18-inch gravitating-main from the sea. The smaller pumping station is situated in a part of the colony which is quite open to an enemy's fire, and the 18-inch main is intended as an auxiliary supply for use in time of war when the supply of brackish water from the wells might be no longer available. The pipe-trench containing these pipes is continued from the foot of the cliff to the pump-well in the engine-room by means of a heading 76 feet in length, 3 feet in width and 6 feet in height, driven horizontally.

*Extracts from The Proceedings of the Institution of Civil Engineers, Vol. clxvii, Session 1906-7; Part 1.

AN OLD MINE FIRE BROKE OUT in the Engleville coal mine, at Engleville, Colo., on May 19, and caused the death of seven men including the superintendent. The fire, which started a year ago, broke out anew and prevented the exit of the miners. The point where the flames crossed the tunnel in which the men were working, was three miles from the opening. It was necessary to tunnel around the fire to reach the bodies.

A TRESTLE WAS DEMOLISHED, a train that was upon it was thrown into Chattanooga Creek, three men were killed and five injured, and three residences and a pile driver wreck, as the result of the premature explosion of a blast in the Lookout Mountain tunnel on the Southern Ry. on May 16. The bridge was crushed by tons of falling rock just as the train was passing over it; other pieces of rock, hurled over 400 yds. by the explosion, caused the damage to the pile driver and residences.

THE INDUCTIVE EFFECT of the high tension overhead circuit, along the line of the New York, New Haven & Hartford R. R., on adjacent telephone and telegraph lines, is reported to be so great as seriously to interfere with the operation of the latter in the vicinity of New Rochelle and Cosco. The telegraph lines are said to have been the worse affected, interference having been so marked at New Rochelle recently that messages had to be sent via Boston.

THE "BELMONT" TUNNEL UNDER EAST River holed through its north tube on May 20. This tunnel, comprising two tubes, extends from Fort ... Borough of Manhattan, to Long Island City, ... City. It is being built by the New York & ... Island R. R. Co. under an old charter which the city ... claim has expired. The tunnel will probably be operated as part of the Interborough Rapid Transit Co. system.

PREVENTION OF ACCIDENTS TO WOMEN is sought by the Association of Italian Manufacturers for the Prevention of Accidents in Factories. A gold medal and $1,000 are to be awarded for a device which will lessen the danger of contact between the primary and secondary coils or leads of transformers. The apparatus must come into action as soon as such a contact is made as causes the voltage between the secondary and ground to rise to double normal value in the case of three-phase apparatus, and to 2½ times normal value for single phase. The voltage must be reduced to normal by means of this device, but the transformer and any auxiliary apparatus must not be put out of working order.

A gold medal and $200 are also offered for a device whereby the danger of accidents from the handles of small cranes is eliminated. These appliances are to be submitted to the Director of the association before July 31, 1908.

EXPENDITURES FOR SAFETY-DEVICES on the Union Pacific-Southern Pacific system are reported in an interesting tabulation issued by the office of the Director of Maintenance and Operation. The figures give the totals for the period from June 30, 1898, to April 24, 1907, practically nine years, and apply to a length of about 15,600 miles of road equipped (at present) with about 80,000 cars and 2,700 locomotives.

ROADWAY DEVICES.	
Block Signals	$5,459,900
Distant Switch Signals	247,000
Interlocking R. R. Crossings	567,400
Gates and Bells at Highway Crossings	52,800
Total Roadway Devices	$6,327,100
EQUIPMENT DEVICES.	
Automatic Couplers	$1,063,000
Air Brakes, etc.	3,286,200
Train Signals	20,400
Grab Irons and Hand Holds	37,700
Electric and Acetylene Headlights	173,000
Total Equipment Devices	$5,506,900
Total, All Safety Devices	$12,834,000

Distributing this over the total mileage, 15,600, it is equivalent to an *average* expenditure of $353 per mile of road; or, during the period covered by these figures, about $40 per mile of road was spent each year on safety devices.

A TRIAL OF ROAD TARRING preparations and machines took place in Middlesex, England, on May 22. Hot tarring of stone roads, under the best conditions, has proven satisfactory in France. It has developed that it is necessary in using clear coal tar to apply it to the road surface above 90° C., which makes machine work imperative. However, a process of emulsifying the tar has been brought out at the Hague. The emulsion is made by mixing ordinary coal tar with five or six per cent. of soft potash soap. To this mixture five or six per cent. of strong soda lye is added and the whole thoroughly churned. For use on roads more water is added; about 3½ gals. to one of the mixture. Four or five gallons of the final product are required for a single dressing of 100 sq. ft. For best results two or three applications should be made with a few days between. In England a road treated in May remained clean and hard as asphalt during the summer. Rainy weather, following a long, dry period, failed to soften it, and the road retained its hard surface until winter.

EXPLOSION TEST LABORATORIES are being constructed for the United States Geological Survey in Denver and Pittsburg, for studying the causes of mine explosions with a view to their prevention. The Pittsburg station will consist of an explosive gallery, rescue room, observation house, lamp testing rooms, and explosives laboratory. This gallery is to be made of boiler-plate and will be in the form of a cylinder, 100 ft. long and 6 ft. in diameter. A series of safety valves on hinges will be arranged along the top to allow the escape of gas following an explosion. Portholes along the sides, covered with half-inch plate glass, will allow those in the observation house to see whether an explosion has taken place in the gallery during the tests. The cylinder will be filled with fire-damp and air, or coal dust and air, and the explosives will be hurled into the gallery by means of a steel mortar fired by electricity

from an observation house 60 ft. away. The fire-damp and air will be thoroughly mixed by an electric fan.

Tests will be made with various explosives and the maximum quantity of each explosive that can safely be used in mines will be published under the head of "Permissible Explosives." Explosives known as "Safety Explosives" in which the temperature at the point of detonation is low and the flame of short duration, will have a higher "Limit Charge" than the less safe explosives.

The experimental room will resemble the interior of a mine and during the tests will be filled with smoke. Miners will be shown how to rescue their fellow miners with special apparatus.

The observation house will run parallel with the explosive gallery 60 ft. away and will give opportunity for a number of persons to witness the tests in safety.

All safety lamps that are now used in this country will be tested, not only for their candle power, but also for their relative safety in the presence of fire-damp. The lamps, which will be tested in a separate room, will be subject to different velocities of explosive mixtures of gas and at various angles.

All explosives will be first tested by the pendulum and the lead block tests, to arrive at the quantity to be used in making experiments in order to get the same disruptive force. A pressure gage will be used for measuring the actual pressure developed by the detonation of various explosives. The analysis of the products of combustion will also be made. The heat of decomposition of all explosives in terms of calories will be ascertained by detonating large quantities in a bomb. The explosives will be fired from the mortar at night and the length of the flame will be determined by photography. The time of the flame will also be determined by an electrical apparatus. The rate of detonation will be determined by an electrical rotary recording drum.

Actual experiments will be made in mines to lessen the waste of fuel in mining operations. Several of the best explosives which have been determined by the results at the testing station will be purchased in the open market. They will be used in different mines and the amounts of lump and slack coal produced will be carefully screened and weighed. A classification of these explosives will be made in reference to the cost of explosive per ton of coal produced. Different methods of using explosives in mines will be investigated with special reference to increasing safety and efficiency.

The experiments will be under the direction of Mr. Joseph A. Holmes, Chief of the Technologic Branch of the Geological Survey. Dr. Charles E. Munroe has technical supervision of the tests which will be conducted at the station. Mr. Clarence Hall, explosives expert for the Geological Survey, assisted by Mr. W. O. Snelling, will have immediate charge of the experiments. Mr. Hall has recently returned from Europe where he made a study of the foreign government testing stations.

THE EIGHT-HOUR LAW on Government work has been finally held constitutional by the United States Supreme Court. This is the end of a long fight made by contractors against the law which forbids any man working over eight hours in each day on any contract for the government. The decision held, however, that the law did not apply to seamen, and in this class were placed laborers and mechanics employed on dredges in river and harbor improvements. Men so engaged are not employed on public works in the meaning of the law. It has also been decided in the lower courts that the law did not apply to men employed on government work in factories where such work was only a part of the daily output of the establishment.

PERSONALS.

Mr. Thomas J. Foley has been appointed Superintendent of Terminals at Omaha for the Union Pacific Ry.

Mr. R. B. Wellman has resigned as Superintendent of the open-hearth department of the Atlanta Steel Co., of Atlanta, Ga.

Mr. Henry S. Thompson has been appointed Commissioner of Public Works of the Borough of Manhattan, New York City.

Mr. W. S. Martin has resigned as General Manager of the Mexican International R. R.; the resignation will take effect May 31.

Col. John G. D. Knight, Corps of Engineers, U. S. A., has been detailed for service at New York City, to relieve Col. D. W. Lockwood.

Mr. Joseph C. Houston has accepted the superintendency of the Right-of-Way mines at Cobalt, Ont. He was formerly with the O'Brien Co.

Mr. W. E. H. St. Lawrence has resigned as Assistant Engineer to the Gabriel Concrete Steel Co. and has become associated with the Illinois Steel Co., of Chicago.

Mr. Henry Miller has been elected Vice-President of the Wabash R. R., in addition to his position as General Manager, to which office he was appointed about two years ago.

Mr. Paul M. Norboe, M. Am. Soc. C. E., has been appointed by State Engineer Ellery, of California, to the position of Assistant State Engineer, with offices at Sacramento.

Mr. Benjamin Magnus recently left New York to take charge of the Electrolytic Refining and Smelting Co., of Australia, Ltd.; his location will be 118 Pitt St., Sydney, New South Wales.

Mr. D. B. Hanna, Third Vice-President of the Canadian Northern Ry., has been appointed General Manager of the entire system. For the present he will perform the duties of both positions.

Mr. Geo. Crerar, recently metallurgist in charge at the San Fernando del Cobre smelter, Mexico, has accepted the management of the Takilma Smelting Co., located in Josephine County, Oregon.

Mr. J. M. Naugle, for many years connected with the Sonora Ry., Mexico, and recently its General Manager, has been appointed Assistant to Vice-President C. R. Hudson, of the Mexican Central Ry. Co.

Mr. H. C. Ferris has been appointed General Manager of the Chihuahua and Pacific R. R., to succeed Mr. C. L. Graves, who has resigned. Mr. Ferris has been Superintendent of the Toledo & Ohio Central Ry.

Mr. H. P. Greenough has been appointed Superintendent of the Mexico division of the Chicago, Rock Island & Pacific Ry., and will take office on June 8. He succeeds Mr. J. F. Sugrue, who has resigned.

Col. Harry C. Trexler resigned May 20 as President of the Lehigh Valley Transit Co. Mr. David Young, of Newark, N. J., was elected to succeed him. On the same date Mr. Edward M. Young resigned as Vice-President.

Mr. Geo. H. Burgess, Engineer of Terminal Improvements with the Erie R. R., has resigned to take a position with the Atlantic, Gulf & Pacific Co., contractors, with offices in the Park Row Building, New York City.

Mr. B. E. Rich, recent Assistant Chief Engineer of the Chicago, Indiana & Southern R. R., a New York Central line, has been promoted to Chief Engineer. Mr. G. Ryan has been placed in charge of the signal engineering department.

Mr. J. Walter Ackerman, Assoc. M. Am. Soc. C. E., City Engineer of Auburn, N. Y., has been retained by the City of Elmira, N. Y., as Consulting Engineer, in the investigation on the advisability of constructing a municipal conduit system.

Mr. Geo. Grant Mason, Division Superintendent of the Chicago, Milwaukee & St. Paul Ry., at Aberdeen, S. Dak., has resigned his position. He was a nephew of the late James Henry Smith, and received $12,000,000 through the latter's will.

Mr. Henry Harris, M. Am. Inst. M. E., who lately resigned as Superintendent of the Hall Mining & Smelting Co.'s smelter at Nelson B. C., has accepted the superintendency of the smelting plant of the Alaska Smelting & Refining Co., at Hadley, Prince of Wales Island, Alaska.

Mr. R. A. Gray has been appointed Division Engineer of the Valley division of the St. Louis, Iron Mountain & Southern Ry., with headquarters at Monroe, La. He succeeds Mr. S. Q. Gibson, who has resigned. Mr. F. Wolffe has been appointed Assistant Engineer with the same headquarters.

Mr. H. R. Nickerson has resigned the vice-presidency of the Mexican Central Ry. Co., which he has held since June, 1899. So far the board of directors has made no appointment to fill the vacancy; the President, Mr. Eben Richards, has taken over Mr. Nickerson's duties at the New York office of the company.

Mr. Lewis E. Ashbaugh, Assoc. M. Am. Soc. C. E., has resigned as Associate Professor of Civil Engineering at Iowa State College, Ames, Iowa, and engaged as Engineering Assistant to Mr. Robert McF. Doble, Consulting and Supervising Engineer at Colorado Springs, Colo., in the work of water power development.

Mr. Bruce R. Warden, M. Am. Inst. M. E., a mining engineer with the Canadian Pacific Ry., has been retained by the Nicola Coal & Coke Co. to superintend the construction of the plant at its Middlesboro Colliery at Coulee, B. C., in the Nicola district. Mr. Warden has been located at the railway's colliery at Bankhead, Alberta.

Mr. Benjamin Campbell, at present Fourth Vice-President of the Great Northern Ry., has been appointed Vice-President of the New York, New Haven & Hartford R. R., with headquarters in New York City. He will have charge of all traffic, freight, passenger, mail and express over the New Haven system, and will take charge on June 1.

The following changes have taken place in the personnel of the Reclamation Service: Messrs. Myrl E. Ready, F. C. Youngblutt and Wm. H. Lincoln have been appointed junior engineers and assigned to the Lower Yellowstone Project; Mr. R. F. Ewald has been appointed assistant engineer and assigned to the same project; Mr. F. J. Israel has been designated special fiscal agent and transferred from the Strawberry Valley Project to the Lower Yellowstone project.

Mr. C. M. Levey, Third Vice-President of the Northern Pacific Ry., with headquarters heretofore at Tacoma, Wash., is to be transferred to St. Paul and placed in charge of maintenance and operation of all of the lines of the company. Mr. R. J. Horn, General Manager, will continue to make his headquarters in St. Paul, and will be in charge of maintenance and operation in Montana, North Dakota, Minnesota and Wisconsin. Mr. H. C. Nutt, former General Superintendent of the Michigan Central R. R., at Detroit, is appointed General Manager of maintenance and operation of all lines in Idaho, Washington and Oregon, with headquarters at Tacoma.

Mr. Leonard Metcalf and Mr. Harrison Prescott Eddy, Members Am. Soc. C. E., have entered into partnership under the firm name of Metcalf & Eddy, with offices at 14 Beacon St., Boston. Mr. Metcalf has conducted a consulting engineering business in Boston for the past ten years, along hydraulic and sanitary engineering lines and the administration of water-works and electric lighting properties. Mr. Eddy has been in charge of the sewerage department of the city of Worcester, Mass., for the past 15 years, during which time he has also served as consulting engineer upon various sanitary works and as an expert in sanitary engineering matters. The new firm will devote itself particularly to water-works, water purification and power, and to sewerage and sewage disposal works.

Mr. Fred. J. Miller, M. Am. Soc. M. E., who has been for nearly twenty years editor of the "American Machinist," resigned his position recently and will take a vacation from active business for a time. Mr. Miller has long been a prominent figure in the field of technical journalism. He joined the editorial staff of the "Machinist" in 1887, and through his practical familiarity with machine shop methods and equipment, he has been able to make that journal a powerful factor in the development of the American machine tool trade. His work in the conduct of the "Machinist" has been uniformly on a high plane and has been of much service in raising standards in technical journalism. Mr. Miller has been prominent for some years in the affairs of the American Society of Mechanical Engineers, having been one of its Managers since 1904. Since his retirement from editorial work he has been rendering important service in connection with the raising of the fund for that society's share in the purchase of the land for the new Engineering Societies Building.

Mr. Marshall O. Leighton, Chief Hydrographer of the U. S. Geological Survey, has been designated by the Inland Waterways Commission as Consulting Hydrographer. He will serve in an advisory capacity in all matters relating to the flow of rivers and related problems of water supply, water power, river pollution, etc., for which duties he is unusually well equipped. He has spent his whole professional life since graduation from the Massachusetts Institute of Technology in water supply work, especially that relating to the rivers of the United States, their flow and power development, and the damages from sewage and industrial pollution. At the present time Mr. Leighton is one of the Flood Commissioners of the State of New Jersey. He will bring to the Inland Waterways Commission a fund of information of great value to that body. Data concerning the amount of water contributed by rivers of the Mississippi drainage basin and other matters of interest to them have already been collected by the branch of the Geological Survey of which he is chief.

Obituary.

Geo. E. Davis, the founder of the "Chemical Trade Journal," and for 20 years its editor, died on April 20 in London at the age of 56 years.

Alonzo Hewitt, Chief Electrician of the Albany & Hudson R. R., and Superintendent of the fire alarm system of Rensselaer, N. Y., was shot and killed by an unknown person on May 16, at the door of his home in Rensselaer.

Wm. H. Harrison, a member of the W. & A. Fletcher Co., shipbuilders and engine manufacturers, of Hoboken, N. J., shot himself on May 17 at the home of his son, Dr. W. N. Harrison, at No. 76 Oakwood Ave., Montclair, N. J. Illness was the cause of his taking his life.

John M. Bell, an old time Montana mining engineer, died on April 23 in Chalchihuites, Zacatecas, Mex., where he had been connected with the Chalchihuites Mining & Smelting Co. Death resulted from blood poisoning, the outcome of a wound received when a horse fell with him seven weeks before.

Wm. J. McLean, a well-known railroad man, died at his home in Roxbury, Mass., on May 14, at the age of 46 years. He began his railroad career as train dispatcher with the Chicago, Burlington & Quincy Ry. in 1877. After serving in various responsible positions with a number of Western roads he was in 1900 appointed General Eastern Passenger Agent of the Illinois Central at New York, and in 1904 New England Manager of the same road, with headquarters at Boston.

Major N. H. Hutton, M. Am. Soc. C. E., died May 8, at the age of 76. Previous to 1861 he was in charge of federal engineering work in various parts of the West, and after that date he was in charge of the construction of the Baltimore defenses. After the war he was in charge

of the Patapsco River improvements and later of the preliminary works of the Western division of the Virginia Central Waterline Canal. For many years he had been Chief Engineer of the Baltimore Harbor Board, and he had also served as Consulting Engineer for a number of important waterway enterprises.

Orrin W. Potter, a pioneer in the steel industry, died at his home in Chicago on May 17 at the age of 70 years. He educated himself in higher mathematics and civil engineering while working as a mill hand and clerk in rolling mills at Wyandotte, Mich. In 1864 he was made Secretary and General Superintendent of the Chicago Rolling Mill Co., and seven years later was elected its President, a position which he occupied until the consolidation of the company with the Illinois Steel Co. in 1886, when he refused to accept office in the larger corporation because of his opposition to the merger. Since his resignation he has been conducting a railway supply business.

Edmund P. Lord, General Manager of the H. K. Porter Locomotive Works at Pittsburg, died of apoplexy at Mercy Hospital, Pittsburg, on May 12; he was 47 years of age. His illness, which was the result of being fallen upon by a horse and internally injured, had kept him in the hospital for three weeks prior to his death. Mr. Lord graduated from Yale in 1871, and afterwards from the Stevens Institute of Technology at Hoboken, N. J. He then entered the employ of the Pennsylvania R. R. and eventually became Assistant Superintendent of Motive Power of the Pennsylvania lines west of Pittsburg. In 1892 he became Superintendent of Motive Power of the Big Four R. R.; a year later he came to Pittsburg as Superintendent of the H. K. Porter Works, and had been with them ever since.

Charles Frederick Cutler, President of the New York Telephone Co., and Chairman of the Board of Directors of the New York & New Jersey Telephone Co., died suddenly of heart disease at Saranac Lake, N. Y., on May 18; he was 66 years of age. Mr. Cutler was also Chairman of the Board of Directors of these companies: The Bell Telephone Co. of Philadelphia, the Delaware & Atlantic Telephone & Telegraph Co., the Chesapeake & Potomac Telephone So., the Hudson River Telephone Co., the Central New York Telephone & Telegraph Co., the Empire State Telephone & Telegraph Co. and the New York & Pennsylvania Telephone & Telegraph Co. He possessed marked executive ability in the line of management of telephone interests, and has done notable work in the development of those interests in the country. He is survived by a wife and two grown children.

Sir Benjamin Baker, one of the most noted of English engineers, and famous as the engineer of the great Assouan Dam in Egypt and the Forth Bridge in Scotland, died at Pangbourne, Berkshire, England, on May 19. He was born in 1840. He was President of the Institution of Civil Engineers during 1895-6; and he has been for some time next to the oldest Past-president of the Institution still living. He was a Fellow of the Royal Society, and also an honorary member of both the American Society of Civil Engineers and the American Society of Mechanical Engineers. For his work as Consulting Engineer of the Assouan Dam the Sultan conferred upon him the First Class of the Order of the Medjidie. He was also a Knight of the Orders of the Bath, of St. Michael, and of St. George, and had received several honorary degrees from the leading universities of Great Britain.

Mr. Samuel L. Morison, President and General Manager of the Jewell Export Filter Co., died in London on May 21. Mr. Morison was born in Baltimore, Md., 56 years ago. He was a descendant of an old Maryland family. He graduated from Harvard in the class of 1873, and became a member of the firm of Gillies, Morison & Co., first representing the Philadelphia house of Morris, Tasker & Co. in New England, and later carrying on an independent business in the sale of water-works supplies. In 1879 Mr. Morison's firm purchased the brass works of Hayden, Geer & Co., and reorganized it as The Hayden Co. Other concerns were taken in, and the United Brass Co. was later formed. After ten years of successful work in the brass industry, Mr. Morison and his partner became interested in the new business of mechanical filtration, taking up first the exploitation in the East of the Jewell patents on mechanical filters. Mr. Morison soon became a prominent factor in the development of the mechanical filter business, and had an active part in several of the organizations which finally were merged in the New York-Continental-Jewell Filtration Co. After the business of mechanical filtration in the United States was placed on a firm basis, Mr. Morison's energies were enlisted in the development of the American mechanical filter for foreign countries. He organized and became president of the Jewell Export Filter Co., and has for several years been carrying on an extensive business in the introduction of mechanical filters in Europe and Asia. Large filter plants at Alexandria and Cairo, Egypt; Trieste, Austria; and in India, Russia, England and France, were carried out under his direction. The most important plant in the United States with whose construction Mr. Morison was intimately connected was that at Little Falls, N. J., which still remains the largest mechanical filter plant in the world. Some three years ago Mr. Morison fell in an office building in New York and broke his ankle. The fracture failed to heal properly and has given constant trouble ever since, although it has not prevented him from continuing in active business. He sailed from New York on the "Baltic" on April 10, but the old wound, which had been growing worse of late, finally caused blood poisoning, which resulted in his death. Mr. Morison was a member of the Society of the Cincinnati, and of the University and Manhattan Clubs in New York City.

ENGINEERING SOCIETIES.

COMING MEETINGS

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 28-31. Semi-annual meeting at Indianapolis, Ind. Secy., Calvin W. Rice, Engineering Societies Bldg., 33 West 39th St., New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 4 to 7. Annual convention at Washington, D. C. Secy., W. C. L. Eglin, 29 West 39th St., New York City.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 12-14. Annual meeting at Atlantic City, N. J. Secy., J. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 17-19. Annual meeting at Atlantic City, N. J. Secy., J. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

AMERICAN WATER-WORKS ASSOCIATION.
June 17-22. Annual convention at Toronto, Ont. Secy., J. M. Diven, 14 George St., Charleston, S. C.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 19, 20. Annual meeting at Atlantic City, N. J. Secy., P. W. Drew, Wisconsin Central Ry., Milwaukee, Wis.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 20-22. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS.
June 25, 26. Annual meeting at St. Paul, Minn. Secy., G. P. Conard, 24 Park Place, New York, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 25-28. Annual convention at Niagara Falls, N. Y. Secy., Ralph W. Pope, 29 West 39th St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Annual convention at the City of Mexico, Mexico, beginning July 8. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

THE BUREAU OF STANDARDS AT WASHINGTON was visited on the evening of May 7 by about 100 members of the Washington Society of Engineers. The heads of the various departments were present, and as parties of visitors called at each, the chief thereof explained the instruments and their functions. Especial attention and interest were given to the experiments performed with the liquid air plant in the low temperature laboratory. The mechanical and physical laboratories were also inspected; the latter, being the testing point for surveyors' tapes, weights, electric and other lamps, etc., proved of material interest to the visitors.

OHIO SOCIETY OF MECHANICAL STEAM AND ELECTRICAL ENGINEERS.—The society met on May 17-18 at the Hotel Algonquin, Dayton, O. On the afternoon of May 17 the plant of the National Cash Register Co. was visited and inspected. At the evening session the following papers were read and discussed: "Thermometry and Temperature Regulation," by H. Y. Norwood; "Some Experiments with Gasoline," by E. W. Roberts; "Steam Power vs. Gas Power," by F. W. Ballard; written discussions of the last were presented by Messrs. J. R. Bibbins, L. G. Finlay, D. L. Fagnan and G. G. Bennett. After a business session on the morning of May 18 papers were presented on "Recent Developments and Future Application of Centrifugal Pumps," by D. S. Brown, and "Purification of Water for Boilers and Laundries," by C. E. Sutton.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.—The next quarterly meeting will be held at the Hotel Chamberlin, Old Point Comfort, Va. No papers will be read.

The association has prepared bulletins No. 14, "Concrete Roadways," containing articles by Messrs. H. L. Weber and Walter E. Hassam, with discussion by members; and No. 15, "Concrete Bridges," written by Mr. Geo. S. Webster. These bulletins are for free distribution, and may be obtained by writing Mr. C. E. E. Bottomley, Assistant Secretary, Land Title Building, Philadelphia.

The second progress report of the Committee on Technical Research has also been printed; it considers the subject of sieves, from the cement maker's standpoint, and of the specific gravity of cement. This pamphlet, which will be of interest to cement testers, can also be obtained free from Mr. Bottomley.

NATIONAL FIRE PROTECTION ASSOCIATION.—The New York offices of the National Fire Protection Association were opened recently in Rooms 815, 816, 817, at the Engineering Societies Building, 29 West 39th St. These offices have become necessary on account of the increasing scope of the association's work and the fact that this work has brought them prominently in contact with various important interests and manufacturers whose goods are built under their specifi... and whose headquarters are in New York City. The association offices will be shared by the Underw... Laboratories of Chicago, which make practically ... of the tests for the association on various retardants, ... nguish-ers, and signaling and other hazardous devic... hich in one way and another affect buildings in wh... hey are installed as to fire hazard.

The new offices will be equipped as rapidly ... possible with all literature and information, specifica... s, etc., pertaining to these associations, so that the ... erested public may be able to inform themselves ex... y as to what is required in order to conform to the m... modern ideas of fire protection engineering practice. The ... ation of the offices in the Engineering Societies Buildi... will also assist in bringing the insurance fraternity, th... gh the National Fire Protection Association, in cl... r touch with the various prominent engineering societ... located in the building, many of which societies are in... sted in specifications affecting building construction a... equipment.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The annual business meeting was held Tuesday, May 21, at the Engineering Societies Building after an informal dinner at the Murray Hill Hotel. The following officers of the institute were declared elected by the President and Board of Tellers: President, H. G. Stott; Vice-Presidents, L. A. Ferguson, J. G. White, W. C. L. Eglin; Managers, B. G. Lamme, H. W. Buck, P. H. Thomas, Morgan Brooks; Treasurer, G. A. Hamilton; Secretary, R. W. Pope.

At the professional session, Mr. F. J. Sprague, Past President, read a paper, "Some Facts and Problems Bearing on Electric Trunk-Line Operation." Mr. Sprague contended that capacity rather than operating economy was the deciding factor in electrification of trunk line. The greatest railroad problem of the present was held to be attaining increased capacity without increased mileage. Direct and alternating systems were compared. Alternating motors were considered much heavier for equal HP., with poorer speed and torque characteristics. The systems of overhead and locomotive construction, at present in use, were outlined.

The paper was discussed by W. J. Wilgus, L. B. Stillwell, W. B. Potter, C. F. Scott, N. W. Storer, G. R. Henderson, C. P. Steinmetz and many others. Most of these men contended that the features of design of alternating current motors were closer to the best direct current practice than Mr. Sprague showed. Standardization was strongly urged by some engineers present and as strongly rejected by others as untimely.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the society's rooms in Chicago on May 15, the Secretary announced that arrangements had been made to keep the library open during the evenings until 9.30 p. m. It is expected that this will be a great convenience to members who have little opportunity to visit the library or reading-room during ordinary office hours.

The paper presented was by Prof. Dugald C. Jackson on "Methods of Electric Lighting for Railway Trains," and was read by Mr. W. B. Jackson in the absence of the author. It related especially to steam consumption and the comparative advantages and efficiency of the three systems of electric lighting in general use: 1. With a steam generating plant in the baggage car; 2. with a generator on each car, driven from one of the axles, and having a storage battery as an auxiliary; 3. with a storage battery on each car, charged at terminal points. The paper was a summary of a series of tests made by students of the University of Wisconsin, under the direction of Prof. Jackson, durng the past two years.

The straight storage system is the simplest, but is not applicable to long runs, and even on short runs it is a question whether the axle-driven generator system is not the more satisfactory. The steam plant generating current for the entire train ranks second in point of simplicity, but requires considerable attention, though some roads train their baggagemen to look after the plant. This system is satisfactory for solid trains making very long runs. The axle-driven generator system has the apparent disadvantage of complexity, but the great advantage of making each car an independent unit as far as lighting is concerned. Objections which have been made to this system are due in part to the fact that the railways have not given proper attention to the inspection and maintenance of the plant, and also to the fact that manufacturers have installed the plant without being careful to see that the cars were properly wired to secure the best results.

The paper dealt with the matter purely from the mechanical and electrical engineering points of view, and did not enter into the question of cost and economy.

On May 11 a party of nearly 100 members and visitors made a trip to the University of Illinois, at Champaign, Ill. Special cars were attached to the regular trains of the Illinois Central R. R., leaving Chicago at 11 a. m. and Champaign at 6 p. m. The greater part of the time was devoted to inspections of the equipment and work of the engineering department and the engineering experiment station.